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STANDARD OPERATING PROCEDURES
ENVIRONMENTAL RESTORATION PROGRAM
ROCKY FLATS PLANT

Rockwell International
Aerospace Operations
Rocky Flats Plant
Golden, Colorado 80464

January 1989

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1.7*	Sampling for Removable Alpha Contamination	January 1989	3	To describe a method of verifying that equipment leaving a controlled area that contains radioactive materials meets unrestricted release criteria for removeable contamination. This equipment may include tools, vehicles, and miscellaneous items brought into contact with radioactive materials.
1.8	Personnel Decontamination --Level D Protection	January 1989	3	To describe the equipment and procedures required for the decontamination of persons who have performed field activities in Level D protective clothing.
1.9	Personnel Decontamination --Level C Protection	January 1989	3	To describe the equipment and procedures required for the decontamination of persons who have performed field activities in Level C protective clothing.
1.10	Personnel Decontamination --Level B Protection	January 1989	3	To describe the equipment and procedures required for the decontamination of persons who have performed field activities in Level B protective clothing.
1.11	Reserved	No date		
1.12*	Air Particulate Sampling with a Real-Time Aerosol Monitor	January 1989	3	To describe the equipment, operation, and procedures for collecting real-time air particulate data.
1.13	Reserved	No date		
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6.10*	Correlation of a Sodium Iodide Detector to the Pressurized Ionization Chamber	January 1989	3	To describe the method for correlating count rates obtained with a sodium iodide (NaI) detector and ratemeter/scaler to the exposure rate measurements taken with a pressurized ionization chamber (PIC).
6.11*	Beta-Gamma Radiation Measurements Using a Geiger-Mueller Detector	January 1989	3	To describe the methodology for measuring beta-gamma radiation levels.
6.12*	Radon-222 Flux Measurements Using Charcoal Canisters	January 1989	3	To provide instructions for determining radon-222 flux from ground surface.
6.13*	Radon-222 Measurements Using Track-Etch Detectors	January 1989	3	To provide detailed procedures and overall guidelines for making long-term average radon-222 (Rn-222) concentration measurements in air with track-etch film detectors.
6.14*	Work Area Radon Measurements in Air	January 1989	3	To describe the methods used to collect grab samples of ambient air and the subsequent quantitative analyses of the samples to determine radon-222 gas concentrations in the work area.
6.15*	Measurement of Gamma-Ray Fields Using a Sodium Iodide (NaI) Detector	January 1989	3	To describe the procedures for making count-rate measurements of a gamma-ray field with a sodium iodide (NaI) detector.
6.16	Heat Stress Monitoring	January 1989	3	To outline the procedure for monitoring heat stress and other measures for protecting workers from heat exhaustion and heat stroke in warm environments.
6.17*	Measurement of Radon-Daughter Concentrations in Air	January 1989	3	To describe the methods used to collect samples of filtered particulates in the air and the subsequent quantitative analyses to these samples to determine radon-222 daughter concentrations.

* SOPs not included as they will not be used during 1989 site investigations.

ASSOCIATED PROCEDURES LISTING

SECTION 1 - GENERAL

		Effective Date	Revision Number	Associated Procedures
1.1	General Instructions for Field Personnel	January 1989	3	None.
1.2	General Surface Geophysics	January 1989	3	None.
1.3	Sample Control and Documentation	January 1989	3	1.1, 1.4, 1.5
1.4	Sample Containers and Preservation	January 1989	3	1.3, 1.5, 1.6 1.8
1.5	Guide to the Handling, Packaging, and Shipping	January 1989	3	1.1, 1.3, 1.4, 1.6
1.6	General Equipment Decontamination	January 1989	3	1.1, 1.7 6.4, 6.11
1.7*	Sampling for Removable Alpha Contamination	January 1989	3	1.1, 1.6 6.4, 6.11
1.8	Personnel Decontamination --Level D Protection	January 1989	3	1.1, 1.6, 1.9, 1.10
1.9	Personnel Decontamination --Level C Protection	January 1989	3	1.1, 1.6, 1.8, 1.10
1.10	Personnel Decontamination --Level B Protection	January 1989	3	1.1, 1.6, 1.8, 1.9
1.11	Reserved	No date		
1.12*	Air Particulate Sampling with a Real-Time Aerosol Monitor	January 1989	3	1.1, 1.6
1.13	Reserved	No date		
1.14	Reserved (Field Survey and Reconnaissance)	No date		

SECTION 2 - WATER SAMPLING

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2.2	Field Measurements on Ground and Surface Water Samples	January 1989	3	1.1, 1.6 2.1, 2.3, 2.4, 2.5, 2.6, 2.8, 2.9 3.1 4.3
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3.2	Aquifer (Slug) Testing	January 1989	3	1.1, 1.6 3.1, 3.3

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5.4*	General Soil Gas Sampling and Field Chemical Analysis	January 1989	3	1.1, 1.6
5.5*	Installation/Operation Sampling of Soil-Water Samplers	January 1989	3	1.1, 1.3, 1.4, 1.5, 1.6
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SECTION 6 - HEALTH AND SAFETY (Continued)

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6.9*	Exposure Rate Measurements Using a Pressurized Ionization Chamber	January 1989	3	1.1, 1.6 6.10
6.10*	Correlation of a Sodium Iodide Detector to the Pressurized Ionization Chamber	January 1989	3	1.1, 1.6 6.9, 6.15
6.11*	Beta-Gamma Radiation Measurements Using a Geiger-Mueller Detector	January 1989	3	1.1, 1.6
6.12*	Radon-222 Flux Measurements Using Charcoal Canisters	January 1989	3	1.1, 1.6 6.6
6.13*	Radon-222 Measurements Using Track-Etch Detectors	January 1989	3	1.1, 1.6
6.14*	Work Area Radon Measurements in Air	January 1989	3	1.1, 1.6

SECTION 6 - HEALTH AND SAFETY (Continued)

		Effective Date	Revision Number	Associated Procedures
6.15*	Measurement of Gamma-Ray Fields Using a Sodium Iodide (NaI) Detector	January 1989	3	1.1, 1.6 6.9, 6.10
6.16	Heat Stress Monitoring	January 1989	3	1.1, 1.6
6.17*	Measurement of Radon-Daughter Concentrations in Air	January 1989	3	1.1, 1.6

STANDARD OPERATING PROCEDURE 1.1

GENERAL INSTRUCTIONS FOR FIELD PERSONNEL

1. PURPOSE

To provide field personnel with instructions regarding activities to be performed before, during, and after field investigations.

2. DISCUSSION

The Remedial Investigation Plan (RIP) contains specific details about procedures and equipment for a given operation. Refer to the RIP for the type of samples, measurements, and tests to be collected or performed. The collection and documentation of data should be performed as described in specific SOPs. These general instructions are intended to supplement the information supplied in the RIP and associated SOPs and clarify the role of field personnel at remedial investigations. These instructions will ensure that field personnel take the proper precautions to understand the site, the objective and the schedule for the field program, their authority, and their responsibilities described in the RIP.

This SOP is supported by others that describe procedures and rationale for performing reconnaissance geophysical and soil gas surveys; soil and rock boring; sample logging; soil and sediment sample collection; installation and operation of vadose-zone instruments and samplers; groundwater monitoring well installation, development, and sampling; operation of sampling equipment; performance of aquifer testing; collection, preservation, handling, packaging, and shipping of samples; decontamination procedures; health and safety monitoring; and radiological surveys.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of this SOP and SOPs 1.3-1.10 is required. In addition, a review of associated SOPs for each task is necessary. The associated SOPs are listed in Section 3.1 of each task SOP. Constant review of the SOPs will ensure that the work performed in the field is legally defensible, well documented, and cost-effective. The decontamination procedures are important for protecting the health and safety of workers.

3.2. Preparation

3.2.1. Office

A. Personnel should review the RIP and associated documentation for a specific operation and obtain all information related to the purpose and intent of the field program. This may include (but is not limited to) the documents listed below.

1. The scope of work or work plan described in the RIP

2. Previous reports related to the site

3. Reports related to the area

4. Site maps

5. Area maps

6. Access agreements

7. The subcontractor's work plan

8. Data collection and equipment checklists

9. Associated SOPs

10. Current Operational Safety Analysis - Job Safety Analysis - Rocky Flats Plant

B. Field personnel are expected to maintain a good working relationship with the client, community, and subcontractors. With this in mind, field personnel should contact installation staff, members of the community (in coordination with installation staff), and subcontractors before work is initiated. During the initial contact, permission to enter private property or security areas must be obtained.

C. Obtain and test all equipment needed for the task. See checklist in Appendix 5.1.

D. All sample analyses must be performed within a time period specified by the Analytical Method. In addition, laboratories are vulnerable to heavy overloads. Contact the laboratory before sampling activities begin to ensure that the personnel are aware of specific requirements for analyses and can complete the work quickly and efficiently.

E. Delays at the freight office can be eliminated by contacting the carrier before arrival with a shipment. The carrier can supply information on regulations and specifications for shipping, the address of the nearest delivery office, and the time of the next freight pickup in the area.

3.2.2. Documentation

A. Obtain a logbook and ER Program data collection forms. All measurements, observations, and instrument readings should be entered on the forms according to the instructions supplied. All entries should be made in black ink that is not water soluble (not a felt-tip pen). If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change. Information that does not require data entry should be entered in the logbook. All logbooks are numbered, bound, and contain numbered pages. Do not alter the logbook or data collection forms in any manner.

B. The information management codes, Station ID codes, and sample identification numbers used in data entry are assigned by the data administrator. This system is necessary to avoid duplication of site identifiers or inaccurate entries. Because the list of codes is continually being updated, SOPs cannot be revised each time a new list is produced.

C. Three days before leaving for any field trip, a previsit/pretravel report form must be submitted to DOE. The report contains information about dates of travel, mode of travel, hotel accommodations, and contact phone numbers. Arrangements for renting field vehicles should be made at this time.

3.2.3. Field

A. Check the condition and operation of all supplies and equipment at the site. Perform calibration checks specified in operators' manuals or appropriate SOPs.

B. Establish decontamination zones and barricades to public access.

3.3. Operation

A. The field personnel monitor and provide technical direction for the field work, log samples, take measurements, and sometimes pack and ship samples.

B. Under direction of the site manager, field personnel may designate sampling or hole locations, depth and completion zones, types and depths of sample, and approve and record procedures, materials, and all activities conducted in compliance with the RIP.

NOTE: Whenever a sample is collected, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a label affixed to the sample container--either a Soil Sample Identification Label or a Water Sample Identification Label. SOP 1.3, Sample Control and Documentation, contains copies of these forms and instructions for completing the forms.

C. Additional duties that the field personnel may perform are described below.

1. Keep a logbook to record information concerning equipment, personnel, site visitors, and activities (start and stop times, supplies used, footage drilled/installed, and site observations), as well as weather or site conditions affecting the activities. The field personnel should note all relevant instructions and information. All information pertaining to a field activity should be entered in a bound book with consecutively numbered pages (see SOP 1.3, Sample Control and Documentation, for instructions on keeping the logbook). Subcontractors should sign/initial the daily log, thereby certifying that the account records agree with their estimates.

2. Telephone the site manager or office headquarters daily and provide a progress report.

3. Observe that the subcontractor complies with the RIP and all applicable permits and licenses.

4. Complete all data collection forms according to applicable instructions as work progresses.

5. Observe whether the subcontractor follows the applicable health and safety requirements. If violations occur, the field personnel should stop work and immediately notify the site manager or site health and safety officer.

6. Monitor air, personnel, and equipment for contamination and record results on appropriate forms or in the logbook.

7. Supervise decontamination of equipment and personnel. Record procedures used for decontamination in the logbook. Collect decontamination solutions in containers for appropriate disposal as specified in the RIP.

8. Notify the site manager of any modifications to the contract that may be appropriate. Work not defined in the RIP should not be initiated without the approval of the site manager.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to the presampling conditions as specified in the RIP. Restoration can include repair of damage to the land surface (tire ruts) or private property (fences), as well as restoration anticipated at the time the RIP was prepared (for example, revegetation or borehole abandonment).

C. Mark sampling locations or survey points with wooden lathe stakes, wooden survey pegs, or metal fenceposts. Write the location ID on the marker or survey flagging so that it is readily visible. Mark groundwater monitoring wells on the guard pipe and inside the casing cap. Use a black marker for wooden stakes, flagging, and the casing cap. Mark the guard pipes with welds or stencils and paint.

D. Shipping samples is the last task in most field operations. SOPs 1.3-1.5 should be used as guides to sample handling and transport. SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples, is a summary of Department of Transportation regulations pertaining to the transport of hazardous substances most commonly sampled in the field. Use SOP 1.5 in conjunction with the appropriate Code of Federal Regulations and guidance supplied by the freight carrier to ensure that packages are documented and properly labeled.

3.4.2. Documentation

A. Record any restoration work in the logbook.

B. Record any uncompleted work in the logbook. This record may include sampling that could not be performed, damage that could not be repaired, or requirements for long-term monitoring (for example, the need to verify instrument readings at different times of the year).

C. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages. Place a diagonal slash on sections of pages intentionally left blank.

D. Review data collection forms for completeness.

E. Submit a travel expense report.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

4. SOURCES

None.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Operational Safety Analysis - Job Safety Analysis

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Overshoes
- ________ Work gloves (2 pairs)
- ________ Acid (10% HCL) bottle
- ________ Clipboard case
- ________ Strapping tape
- ________ Pin hammer
- ________ Tape measure (tenths)
- ________ Protractor
- ________ Hat
- ________ First aid kit
- ________ Sun screen
- ________ Thermoluminescent dosimeter (TLD)
- ________ Safety shoes/boots
- ________ Ziplock bags
- ________ Preprinted labels
- ________ Distilled (organic-free) water
- ________ Methanol (Nanograde)
- ________ Freight forms
- ________ Telephone directories
- ________ Chain-of-custody forms
- ________ Hard hat
- ________ Pieces of wood (2 inches x 2 inches x 8 inches) to indicate core loss intervals

APPENDIX 5.1, continued

EQUIPMENT AND SUPPLIES CHECKLIST

________ Stamped, addressed envelopes (large and regular sizes)

________ Phone and gas credit cards

________ Calculator

________ Pens, pencils, and permanent markers

________ Package cord

________ Flagging

________ Hand lens

________ Tool box

________ Rain suit

________ Camera

________ Ear plugs

________ Stopwatch

________ Cold-weather gear

________ Alpha meter

________ Safety glasses

________ Kitchen screen (determine lithology)

________ Ice chest

________ Bound logbook

________ Data collection forms

APPENDIX 5.2

OPERATIONAL SAFETY ANALYSIS - JOB SAFETY ANALYSIS

JOB TITLE: Remedial Investigation Drilling and Sampling Program

OPERATION: This JSA describes procedures and guidelines to be followed during the drilling and ground water sampling for the Remedial Investigations (RI) Program. The Comprehensive Environmental Assessment and Response Program (CEARP) Health and Safety Plan outlines the general procedures of health and safety control. Specific procedures related to Plant permits, personnel, procedures and waste handling as well as job responsibilities are provided in this JSA.

Basic Jobs/Responsibility	Potential Hazard	Hazard Control
1. Excavation Permits and Land Use Permits. Construction Coordinator, Environmental Management are responsible.	Underground utilities, powerlines, flame control, general safety and improper land use.	Inspection of each drilling site by Construction Management. Inspect for listed hazard identification and general safety regulations and to monitor buffer zone activity to minimize environmental impacts.
2. Coordinate overall job safety. CEARP Health and Safety Coordinator is responsible for the implementation of the CEARP Health and Safety Plan.	Personnel exposure to radioactive and/or hazardous wastes and bodily injury.	The CEARP Health and Safety Coordinator is responsible for implementation and auditing of the requirements in the CEARP Health and Safety Plan. The Coordinator is also responsible for the coordination of passive charcoal dosimeters to assess organic exposure levels.
3. Restricted access to drilling operations. The CEARP Health and Safety Coordinator and the Subcontractor Health and Safety Coordinator are responsible.	Contaminant contact. Minimize contact by wearing appropriate designated protective clothing.	Designated contaminated sites are those areas delineated with a barbless fence. The restricted access boundary is extended outward to include drilling operations within 30 feet of of a barbless fence. All personnel, visitors included, must wear white coveralls and booties prior to entering or visiting a designated contaminated site. Personnel entering drill rig exclusion zones

Basic Jobs/Responsibility	Potential Hazard	Hazard Control
3. (Continued)		(a physically delineated boundary approximately 30 feet around the working area of each rig) must wear personal protective clothing and equipment specified by the CEARP Health and Safety Coordinator.
4. Radiation Survey of Personnel and Equipment. Radiation Monitoring is responsible for surveying and release of personnel and equipment from designated contaminated work sites. The site geologist or the subcontractor Health and Safety Coordinator will notify radiation monitoring when needed.	Radiation migration from control area to clean areas.	All personnel, samples, drilling core and equipment will be surveyed by radiation monitoring and must meet plant requirements before being released from the area.
5. Radiation Survey of drilling location. Construction Coordinator and Radiation Monitoring are responsible.	Radionuclide resuspension and impact assessment.	A pre-drilling survey using a fiddler will be performed to determine the baseline for each location near designated contaminant sites or within the Plant perimeter fence. A post survey will also be performed to assess any impacts at the end of each day.

Basic Jobs/Responsibility	Potential Hazard	Hazard Control
6. Ambient Air High Volume CEARP Health and Safety Coordinator and the Subcontractor Site Health and Safety Coordinator will coordinate with Environmental Management.	Contaminant resuspension.	Ambient air sampling (with high volume air samplers) will be required only where the potential for the resuspension of radioactive soil exists. The need for ambient air sampling will be determined separately for each site by the Environmental Management personnel member responsible for signing the excavation permit. Position ambient air high volume air samplers equipped with ground fault protection downwind at operations. Filters to be changed daily by Radiation Monitors. Reviews and/or discontinue operation if any of the following exists: 1) Wind velocity exceeds 15 mph. Environmental Management will evaluate the impact of between 10 and 15 mph. Continuation of the drilling operation will be based upon the type and location of the drilling activity. Vehicular traffic must be minimized. 2) If radiation monitors determine cutting activities are over background, moisture control and/or a soil stabilizer (e.g., coherex) must be used for dust suppression. 3) Ambient air high volume samplers of total long-lived alpha which exceed 0.03 - 0.06 pCi/m^3 will require corrective action based on recommendations by Environmental Management and Radiation Safety.

Basic Jobs/Responsibility	Potential Hazard	Hazard Control
7. Restricted vehicular access.		
Subcontractor site manager and the Subcontractor Health and Safety Coordinators as well as the RCRA site manager are responsible for implementation. Construction Coordinator is responsible for coherex and gravel application.	Contaminant resuspension and environmental impacts.	Access paths which will be used by vehicles will be prepared with gravel and/or soil stablizer (coherex) as determined necessary by Environmental Management personnel. This will reduce erosion and soil resuspension. Vehicular traffic in the vicinity of of the 903 Pad area will be restricted to only prepared surfaces. These road surfaces must be built **ON TOP OF** the present ground cover of the area <u>without</u> cutting or scraping the present ground surface.
8. Drill Cutting Handling. Determine if drill cuttings are "contaminated" (see Reference: Operational Safety Analysis No. RFOSA (Sept. 7, 1984). Radiation Monitoring is responsible. The drill rig geologist will coordinate with the CEARP's Health and Safety Coordinator and the Subcontractor Site Manager on containment of drill cuttings. The CEARP Health & Safety Coordinator will contact a waste inspector, and a decontamination worker to shovel cuttings/sludge into a half-box, a carpenter to seal half-box, and trucking to ship the half-box to the 750 pad area.	Potential contamination of otherwise non-contaminated areas and limit personnel exposure.	If drill cuttings at a drill site exceed background (approximately 250 cpm using a Fidler as references in OSA1) as determined by Radiation Monitors, cuttings will be placed in designated half-boxes. If radioactivity is below background (approximately 250 cpm), cuttings will be distributed on the surface of the immediate area. If organic contaminants are continually detected above background during drilling by the rig geologist's by direct reading instruments, the drill cuttings will be boxed. If the drilling core is over background (approximately 250 cpm), the core will also be

Basic Jobs/Responsibility	Potential Hazard	Hazard Control
		contained in the designated half-boxes. If above background reading of contaminants are detected all drilling fluid contained in the sediment basins from rotary drilling will be decanted into a tanker truck. Care must be taken to prevent sediment from entering the tanker. The remaining cuttings/sludge will be mixed with absorbent material (vermiculite and cement) and placed into a half-box.
9. Fluid Handling.		
The CEARP Health & Safety Coordinator & Subcontractor Site Manager are responsible for contracting the onsite laboratory for sampling. Liquid Waste Operations for any sludge. A sample from each tanker truck shipment will be taken prior to its transfer to Liquid Waste Processing. In addition, Radiation Monitoring must be contacted to survey all containers before exiting the site. Handling & transportation of the liquid to Liquid Waste Processing will be provided by Liquid Waste Operations.	Surface sediment contamination.	Fluids used at drilling locations which have above background concentrations of radioactivity and/or organics as determined from the drill cuttings, will be contained (see Step 8). Fluids will be collected in decontamination troughs. The liquid in these troughs will be decanted into a tanker truck. Care must be taken in preventing sample sediments from entering the tanker. The remaining solids left in the troughs will be mixed with absorbent material (vermiculite and cement) and placed in a half-box (see Step 8). If any volatile organic compounds detected 1.0 ppm above background in the headspace of each well the ground water will be contained. Headspace

Basic Jobs/Responsibility	Potential Hazard	Hazard Control
		analyses will be performed by the samplers using a HNu photoionization detector. Ground water generated from well development and purging will be contained and processed by the samplers. If no volatile organic compounds are found the water will be disposed of on the ground surface in the immediate area. If above background radionuclide activity is detected during drilling in the zone of well completion the ground water will be contained.
10. Trash Generation.		
Drill site workers are responsible for collection and containment of solid trash in designated containers.	Wind blown contaminated debris.	Trash generated within the exclusion areas of each drilling rig operating must be contained. This trash is to be placed in black and white "skunk" drums. Care must be taken to segregate non-contaminated trash from potentially contaminated trash. Non-contaminated trash will be disposed of in sanitary dumpsters.
Construction Coordinator and the Subcontractor Site Manager are responsible for contacting Waste Operations for transfer of solid waste trash drums.		All personal outer protective clothing (e.g. gloves, tyvex disposable booties, rags) used in exclusion zones must be placed in garbage bags. These bags are then to be placed into double vinyl lined bags designated for drums. Final disposition of drums will be determined by Waste Operations Coordinator.

Basic Jobs/Responsibility	Potential Hazard	Hazard Control
11. Proper Labeling of Waste Containers. Solid and Liquid Waste Operations management are responsible for proper labeling.	Illegal or unsafe storage, treatment, and disposal.	Waste Operations will determine appropriate labels for radioactive and hazardous waste constituents generated from the drilling program.
12. Field Activities Near Rifle and Pistol Ranges. CEARP Health and Safety Coordinator and the Subcontractor Health and Safety Coordinator are responsible.	Bodily injury due to gunshot wound.	All personnel operating south of access road east of the perimeter fence and west of Pond C-2. Call Dispatcher x-2444. Reference: OSA: Firearms & Ammunition Storage. No. 121.1.
13. Off-site Shipping of Samples. The RCRA and subcontracting site managers are responsible.	Proper shipping containers and labels to ensure proper handling and response in case of accidents.	Samples which have been determined to meet the definitions of hazardous materials in Part 173 or Title 49 of the Code of Federal Regulations (49 CFR) will be packaged, marked, labeled, described and transported in compliance with the requirements of 49 CFR Parts 171 through 178. Environmental samples which are not subject to the above 49 CFR parts will be transported in accordance with 40 CFR (d)(2)(ii)(A) and (B). For more information call Traffic at Ext. 2377 or Ext. 2378.

STANDARD OPERATING PROCEDURE 1.2

GENERAL SURFACE GEOPHYSICS

1. PURPOSE

To describe the general procedures for acquiring surface geophysical data that aid in buried waste delineation and geologic, hydrogeologic, or other interpretation related to hazardous waste site characterization.

2. DISCUSSION

The Remedial Investigation Plan (RIP) contains specific details about the procedures, equipment, and sampling frequency for geophysical surveys. Refer to the RIP for the type of measurements to be collected and the location of the survey/sampling area.

The six geophysical techniques available for hazardous waste site characterization are metal detection, magnetometry, ground-penetrating radar (GPR), electromagnetics (EM), electrical resistivity, and seismic refraction. Metal detectors, EM, and magnetometry are useful in locating buried metallic wastes. GPR, EM, and magnetometry can define the boundaries of buried trenches and other subsurface disturbances. Electromagnetic and electrical resistivity methods can help define plumes of contaminants in groundwater. Electrical resistivity, seismic, electrical, and GPR techniques are useful in determining geologic stratigraphy and depths to the water table.

In general, the survey should be performed and the results interpreted by qualified technical personnel operating the surface geophysical equipment. Therefore, this SOP provides a means of consistently performing the various surface geophysical methods, a means to perform calibration checks of geophysical survey equipment in the field, and guidance for interpreting the results obtained from the various surface geophysical techniques, rather than specific details of instrument operation.

The following quality assurance procedures apply to all geophysical instruments used during data acquisition.

1. All sample transmittals should be documented on a standard chain-of-custody form (see SOP 1.3, Sample Control and Documentation). Copies of the Custody Transfer Record/Lab Work Request form should be maintained by the field manager.

2. All geophysical instruments should be operated according to operating instructions supplied by the manufacturer.

3. Battery voltage levels for all instruments should be monitored each day throughout the survey. Battery packs should be charged or replaced when voltage levels fall below the level specified by geophysical equipment manufacturers.

4. All instruments should be calibrated as follows: Manufacturer calibrates once prior to initial shipping and after repair. The operator performs a field calibration check before every run. A bench calibration os performed every year. The probes are run through calibration modules as appropriate. Calibration records will be maintained in the office where the instrument is stored between investigations. A copy of the calibration records should be kept with the equipment at all times. More frequent calibrations may be necessary if field measurements indicate possible instrument malfunction.

5. The resolution achieved with geophysical surveys is affected by several factors, including the geology of the site, the quality of baseline information, characteristics of wastes and waste disposal practices, cultural features, and survey grid spacing. The requirements for specific geophysical surveys should be described in the RIP.

3. PROCEDURES

3.1. Associated Procedures

Because of the uniqueness of geophysical surveys, a review of associated procedures is not appropriate.

3.2. Preparation

3.2.1. Office

A. Review the RIP, Installation Generic Monitoring Plan Sampling Plan, Quality Assurance Plan, and Technical Data Management Plan.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Ensure the proper operation of all geophysical survey equipment, as appropriate, using the equipment manuals provided by the equipment manufacturer.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Verify that the survey operator has the required equipment for the appropriate geophysical methods used. Be sure all the equipment, including support equipment, is complete and operational.

B. Establish grid and stake locations or set up traverses for location(s) of sampling stations.

C. Most geophysical instruments will be calibrated at the factory on a periodic basis, depending on the manufacturer's recommendation. However, calibration checks for certain instruments can be conducted in the field. Perform accuracy and reproducibility checks in the field by reoccupying base stations at periodic time intervals.

3.3. Operation

In geophysical survey data recording, store numerical data from surface geophysical surveys on IBM PC-compatible diskettes. On a daily basis, store data on at least three diskettes. Two diskettes remain at the work site as an original and backup. Ship the third diskette to the Document Control Office. Shipment should occur daily.

Use portable computers to download data from automatic recording devices and produce diskettes. In the event that the geophysical survey data is recorded without an automatic recording device or a portable computer, the operator should provide a hard copy of the recorded data that documents the results of the geophysical survey.

Include the data fields listed below in records of surface geophysical data.

1. Site code
2. Location ID (or station)
3. Date
4. Time
5. Geophysical survey data

Record these data in the standard Information Management System (IMS) format. Examples of IMS codes and instructions for using the codes should be provided by the data administrator. Base station values and calibration measurements do not need to be recorded on diskette; however, they must accompany the diskette record in paper copy. Reserve the first record of each file for the site description and comments.

Include a diagram of the measurement locations with the data records on a daily basis. The diagram indicates grid alignment, station numbering (if used), and base station location(s). Record data using the standard IMS code format.

If more than one site is investigated in a day, record the data for each site as a separate file. Include a written description of each file, the file name, and site with the data diskette in shipment.

3.3.1. Electrical Resistivity

The electrical resistivity method measures the apparent electrical resistivity of the hydrogeological section that includes the soil, rock, and groundwater. An electrical current is injected into the ground by a pair of surface electrodes. The resulting potential field (voltage) is measured at the surface between a second pair of electrodes. Because of the length of the wire cables, the types of connections on the resistivity electrodes, and the manner in which the electrodes contact with the ground, there are a number of possibilities for poor electrical contact and short circuits in the resistivity array. These conditions are monitored by observing instrument readings and trends in the data.

Apparent resistivities are calculated and plotted during field acquisition as a means of quality control depth. Sounding curves should be relatively smooth. Abrupt changes commonly occur in sounding and profiling data. Unwanted noise may be caused by near-surface inhomogeneities, electrode contact problems, or changes in hydrogeology.

3.3.2. Seismic Refraction

Seismic refraction techniques are used to determine the travel time or velocity of seismic waves within layers and interpret the thickness and depth of geologic layers. Seismic refraction methods are often used to map depths to specific horizons like bedrock, clay layers, and the water table. In addition to mapping natural features, other secondary applications of the seismic method include the location and definition of burial pits and trenches at hazardous waste sites.

Quality control can be achieved through the methods described below.

A. Check the seismic signal and noise conditions on the instrument display to verify the proper functioning of the source geophones and trigger cables and the correct setting of the instrument.

B. In cases where paper records are not produced, immediately plot arrival time picks made from the electronic display on a time/distance graph in the field. Problems with improper picks are often discovered through an early inspection of these plots.

C. If it is expected that the data are to be used for legal purposes or reviewed by persons other than the field party chief, make a hard copy of the data. Multi-channel systems provide a more efficient means of acquiring and presenting data than single-channel units.

D. Background or off-site data are often required for correlation to known geologic information and to establish clean background data. This information is also useful as a reference for evaluating complex site conditions.

E. If possible, obtain and review boring logs before the survey in order to minimize the possibility that hidden layers or velocity inversions will remain undetected.

F. The manufacturer should perform the electronic calibration of the timing circuits of the seismograph. Because these timing circuits are crystal controlled and have inherently low drift, this is rarely necessary. Normal annual factory maintenance should include such calibration.

G. Conduct a seismic profile at a standard base location periodically to check the operation of the instrument.

3.3.3. Electromagnetics

The electromagnetic method detects lateral and vertical variations of electrical conductivity in the subsurface environment. Quadrature component measurements relate to the apparent electrical conductivity of a material and are influenced by clay content, porosity, moisture content, pore fluid specific conductance, and permeability. These measurements are also influenced by highly conductive materials like metals and graphite. In-phase component measurements are particularly sensitive to highly conductive materials and sometimes used for metal detection. The EM is applicable for the assessment of natural hydrogeologic conditions and the mapping of many types of contaminant plumes. Trench boundaries, buried conductive wastes, and steel drums, as well as metallic utility lines, can be located with EM techniques.

EM instruments are calibrated annually over a massive rock outcrop used as a geologic standard by the manufacturer. After calibration, the instruments will generally retain their accuracy for long periods. On large projects, establish a local standard site in the field. This will provide a reference base station to check the instrument's performance and allow correlation between instruments.

Calibration Check

A. Before conducting a survey, select a temporary site on location for daily base station measurements and calibration checks. Calibration checks should be made twice daily, before and after conducting daily survey operations. Readings will repeat within approximately 10%. Originals of all calibration records should remain at the site. Submit copies to the field geophysicist.

NOTE: Do not make calibration checks in the presence of sources of cultural interference like power lines or buried utilities. Make them on a relatively flat surface outside of topographic lows and away from areas that may include subsurface waste materials.

B. Instrument stability should be checked by the field operating party when there is local or distant thunderstorm activity. Electromagnetic radiation from thunderstorms can generate noise in the EM system. Operations may have to be postponed during thunderstorms.

C. Exercise technical judgment so that conductivity readings recorded in the field are reasonable with respect to existing site conditions.

D. Record instrument sensitivity settings in the logbook if an automatic recording device is not used.

E. When using an automatic recording device, enter the readings from the first and last stations of each traverse in the logbook. Compare these data to data from the automatic recorder at the end of each day. Recorded data and field transcribed data must agree to within ± 5% to meet acceptability requirements.

F. Where the conductivity survey traverses cross at grid nodes, the data from the two traverses will be compared. The data should be ±10% of one another for the same instrument (EM 34-3 or EM 31) and ±20% for different instruments (EM 34-3 or EM 31). If the differences exceed these ranges, then the three consecutive readings with the respective instruments will be taken at the grid node. The three readings will be averaged and compared to the measurements in question. If either measurement exceeds their error range, then that survey traverse will be suspect and the data considered unusable.

3.3.4. Ground-Penetrating Radar

GPR uses high frequency radio waves to acquire subsurface information. From a small antenna that is moved slowly across the surface of the ground, energy is radiated downward into the subsurface and reflected back to the receiving antenna, where variations in the return signal amplitude versus time are continuously recorded. This produces a continuous cross-sectional picture or profile of shallow subsurface conditions. These responses are caused by radar wave reflections from interfaces of materials having different dielectric properties. Such reflections are often associated with natural hydrogeologic conditions like bedding, cementation, moisture, clay content, voids, fractures, and intrusions, as well as man-made objects. The radar method has been used at numerous hazardous waste sites to evaluate natural soil and rock conditions, as well as to detect buried wastes.

The radar system measures two-way travel time from the transmitter antenna to a reflecting surface and back to the receiver antenna. Calibration of the radar system and data requires the two-step process described below.

- First, accurately determine the total time window (range) set by the operator.

- Second, determine or estimate the electromagnetic velocity (or travel time) of the local soil/rock condition.

After completing these two steps, the radar unit data will be set for depths to particular features.

Calibrate the time window that has been picked for the survey by using a signal calibrator in the field. This device is used to produce a series of time marks on the graphic display measured in nanoseconds. These pulses are counted to determine the total time of the radar unit. A calibration curve can be designed for each radar system.

Trenches, buried pipes, and road culverts can provide a radar target of known depth. The depth of a known target, a radar record taken over the known target, and a time scale provided by the signal calibrator should provide a basic calibration record. From these data, a velocity can be accurately determined at the given target location. Because this approach may give accurate calibration at the specific site, the assumption must be made that conditions in other areas to be surveyed are the same as in the calibration areas. If they are not, errors will occur in determining depths.

If significant changes in soil type or moisture content occur with depth, velocity will not be the same throughout the vertical radar profile. Therefore, the vertical radar depth scale will be nonlinear.

Calibration Check

A. Before conducting a survey, take a GPR traverse over a buried object of known depth (if available at a particular site). From the two-way travel time and the measured burial depth of the object, the average electromagnetic wave velocity in soil can be calculated from the equation below.

$$V = 2d/t$$

The average dielectric constant of the soil is then calculated using

$$Er = c^2/v^2 = 1/v^2$$

where

v= average electromagnetic wave velocity, feet/nanosecond
t= two-way travel time, nanoseconds
d= distance of antenna to the buried object, feet
Er= average relative dielectric constant of the soil (unitless)
c= velocity of light in air equal to 1 foot/nanosecond
v= average electromagnetic wave velocity of the soil, feet/nanosecond

Note: The above assumes a soil with a relative magnetic permeability of 1 (unitless).

Exercise technical judgment to insure that soil velocity and relative dielectric constant values are reasonable with respect to existing site conditions.

B. Repeat a short GPR traverse twice daily over a known feature before and after conducting daily operations. Exercise technical judgment to insure that any variations between repeat readings are caused be changing soil conditions, rather than the electronics.

3.3.5. Metal Detection

Metal detectors (MD) are electromagnetic devices designed to locate metallic objects buried near the surface. In hazardous waste site investigations, MDs are invaluable for detecting utility lines, survey markers, steel drums buried at shallow depths, and delineating areas that may potentially include metallic waste materials.

Metal detectors respond to nearby metallic objects in a relative way. For instance, closer or large metallic targets create a greater output level than more distant or smaller ones. An experienced operator can usually make a reasonably accurate estimate of target size and depth. Any attempt at detailed calibration will probably be useless because of the many variables involved. For example, calibration curves relating MD meter response to a steel drum as a function of distance may be accurate under a given test standard condition. Unfortunately, these curves are seldom valid because of the variability and complexity of actual field conditions. In addition, the operator cannot easily determine the difference between a single drum located at medium depth and several drums at deeper locations. However, he/she can report that drum-sized targets are present in certain specific areas.

The metal detector will be operated in accordance with operating instructions as supplied by the manufacturer. The metal detector will be operated in the ground reject mode as outlined in the operating instructions. The ground reject mode balances out ground mineralization for better detection of ferrous and nonferrous metals in the ground. Prior to conducting a survey, a location will be selected for daily nulling procedures. The daily nulling location should be free of power lines, buried utilities, and groups of large metal objects. The nulling procedures will be made before and after conducting daily survey operations. The settings of the null adjustments will be recorded in the calibration log book. Adjustment of the sensitivity control will be made on site as required.

3.3.6. Magnetometer

Magnetometers are used to locate metallic objects buried near the surface like buried well casings, utility lines, and survey stakes. At hazardous wastes sites, magnetometers are commonly used to locate buried steel drums and tanks and delineate the boundaries of trenches and landfills. Ferrous metal objects carried by the operator will have a detrimental effect on the accuracy of the magnetometer data. Therefore, metal items like rings, watches, belt buckles, coins, and steel-toed boots should not be worn by the survey team.

Total field and vertical field measurements may be corrected for the diurnal variation of the earth's magnetic field by employing a reference base station magnetometer. Changes in the earth's field are removed by adding or subtracting variations of fixed base station readings from the moving survey data. Gradiometers do not require the use of a base station because they inherently eliminate time variation in the data.

Calibration Check

A. The magnetometer will be operated in accordance with operating instructions as supplied by the manufacturer. Operating instructions for the EG&G Geometrics Portable Proton Magnetometer/Gradiometer (Model G-856AG) will be provided with the instrument.

B. Maintain calibration records from the magnetometer manufacturer. The magnetometer will be calibrated annually by the manufacturer and the date of most recent calibration will be tagged and affixed to the instrument.

C Perform quarterly calibration checks using a magnetometer tester for the proton magnetometer. Quarterly calibrations will be documented in the calibration log book.

D. A swing sensor test will be conducted with the proton magnetometer prior to initiating site operations. For inclinations of the earth's magnetic field greater than 45^{0}, four readings with the sensor oriented 90^{0} to the other readings shall be taken. This will be repeated three times. Variations greater than ± 0.2 gammas will not be observed. Any directional sensitivity of the probe will be corrected by washing the sensor with detergent and water.

NOTE: At Rocky Flats Plant, the earth's magnetic field is dipping approximately 70^{0} North.

E. Obtain a daily background reading in the immediate vicinity of the survey site. This reading will be outside the influence of man-made magnetic fields (e.g., power lines and pipelines). The Geophysicist will confirm that background readings are reasonable with respect to the total magnetic field for the site's latitude and longitude. This daily background reading should repeat to within reasonable diurnal variations in the earth's magnetic field. Generally, acceptable repeat readings are within 50 to 100 gammas.

NOTE: The total magnetic field intensity for Rocky Flats Plant is approximately 55 to 60 kilogammas.

F. Sequential readings will be taken before and after magnetic surveying operations. These readings (within 10 seconds of each other) will be taken at any location on site, preferably at the location of the daily background readings. The readings will be distant from man-made magnetic fields and recorded in the field notebook. Two or three sequential readings will be sufficient. In the absence of magnetic storms (sudden variations in the earth's magnetic field), the drift in the readings should be less than 0.1 to a few tenths of a gamma. Drift during magnetic storms may approach 1 gamma. Records of the daily sequential readings will be recorded in the field notebook.

G. Base station readings will be taken so that the effects of diurnal variations in the earth's magnetic field can be removed from the data. In addition, magnetic storms can be detected if the base station sampling frequency is high enough. During a magnetic storm, operations will be suspended and resumed when the storm has passed. A permanent base station may be set up on site where continuous readings are automatically recorded every ten to fifteen minutes, or a base station may be occupied every 45 to 60 minutes during the survey.

H. Use of automatic magnetometers requires recording the magnetometer readings for the first and last station of each traverse in the field notebook. Data recorded in the field notebook will be compared at the end of the day with data from the automatic recording device. Data recorded in the field notebook should be within $^{+}1$ gamma of the values derived from the recording device. If the differences exceed $^{+}1$ gamma, then the traverse will be suspect and the data considered unusable. Data will be transferred daily onto hard copies from the recording device.

I. Where the magnetic survey traverses cross at grid nodes, data from the two traverses will be compared. The data should be $\pm 10\%$ of one another. If the differences exceed $\pm 10\%$, three consecutive readings will be taken at the grid pond node. The three readings will be averaged and compared to the two measurements in question. If either measurement exceeds $\pm 10\%$, then that survey traverse will be suspect and the data considered unusable.

J. Obtain a daily background reading in the immediate vicinity of the site to be surveyed. This reading should be outside the influence of all possible sources of cultural magnetic fields (for example, power lines or pipeline). Technical judgment will be exercised, so that the background reading is reasonable regarding published data for the total magnetic field intensity at the site latitude and longitude. This daily background reading should repeat to within reasonable diurnal variations in the earth's magnetic field.

K. During cold weather, the battery pack for a fluxgate magnetometer will be maintained at a relatively warm temperature. This is most easily done by surveying with the battery pack beneath the operator's coat or jacket.

3.3.7. Vertical Electrical Soundings (VES)

The VES system will be operated in accordance with operating instructions as supplied by the manufacturer. Operating instructions for the Bison BOSS System (Model 2365) will be provided with the instrument.

Maintain calibration records from Bison Instruments, Inc. The VES system will be calibrated annually by the manufacturer and the date of the most recent calibration will be tagged and affixed to the instrument.

Perform quarterly calibration checks at a designated location. The location should be clear of power lines, buried utilities, etc. The location should also be on a relatively flat homogeneous surface. The quarterly readings should repeat to ±5%. If the differences exceed ±5%, the instrument will be returned to the manufacturer for calibration. Quarterly calibrations will be documented in the calibration log book.

All VES data will be checked for accuracy prior to completion of the sounding. The technique outlined in the manufacturer's operating instructions will be followed. If the cross-checks exceed ±5%, a minimum of three sets of readings will be conducted after a thorough check of the setup. The average of the three sets of readings will be used for the data analysis. Should the cross-checks exceed ±5% on a regular basis, the instrument will be returned to the manufacturer for calibration.

3.4. Postoperation

3.4.1. Field

A. If the equipment has come in contact with contaminated soil or wastes, decontaminate all equipment (see SOP 1.6, General Equipment Decontamination).

B. Make sure all survey locations are staked and the location ID readily visible on the location stake.

3.4.2. Documentation

A. Record all observations and notes concerning any uncompleted work in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign all pages. Place a diagonal slash on sections of pages intentionally left blank.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCE

Benson, R. C., R. A. Glaccum, and M. R. Noel. 1983. "Geophysical Techniques and Sensing Buried Wastes and Waste Migration." U.S. Environmental Protection Agency document, Las Vegas, Nevada.

5. APPENDIXES

None

STANDARD OPERATING PROCEDURE 1.3

SAMPLE CONTROL AND DOCUMENTATION

1. PURPOSE

To define the steps necessary for sample control and identification, data recording, and chain-of-custody documentation.

2. DISCUSSION

The Remedial Investigation Plan (RIP) contains specific details about the procedures and equipment for this SOP. Refer to the RIP for the type of samples to be collected and the destination of the collected samples. Collection and measurement of samples and the documentation of data will be performed as described in specific SOPs.

This SOP describes the methodology of sample control and documentation for all projects. Sample control and documentation are necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, correspondence, sample labels or tags, chain-of-custody reports, photographs, and analytical records. Waterproof black ink must be used in recording all data in documents bearing serial numbers.

The logbooks are assigned to field personnel under the supervision of the quality control officer. There may be several logbooks; for example, there may be a separate logbook for field activities, one for samples, and one for instruments. The quality control officer numbers the logbooks and assigns them to individuals designated for specific tasks of the project. All information pertinent to a field activity must be entered into a logbook. A record of uncompleted work is kept in a logbook. All project logbooks are turned over to the document control officer at the end of each work period and to a central file at the end of the field activity.

All logbooks are numbered and bound, and the pages are numbered. Waterproof black ink is used for recording all data. Logbook pages should never be removed, and no data should removed. To change an incorrect entry, the individual draws a line through the entry, writes the change above the entry, dates and initials the change. If anyone other than the person to whom the logbook is assigned makes an entry, that person dates and signs the entry.

Record all information pertinent to the sampling activity (for example, date, site, ID number, and location) in the logbook. Note the field conditions, weather conditions, and any unusual circumstances. Notes should be as descriptive and inclusive as possible. A person reading the entries should be able to reconstruct the sampling situation from the recorded information. Language should be objective, factual, and free of personal feelings and inappropriate terminology.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.4	Sample Containers and Preservation
1.5	Guide to the Handling, Packaging, and Shipping of Samples

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

F. Contact the carrier that will transport samples to obtain information on regulations and specifications.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

Field preparation requires organizing sample bottles, sample labels, and documentation in an orderly, systematic manner that promotes consistency and traceability of all data. Appropriate items should be completed before a sample is collected.

A. Record all pertinent information (for example, date, site, ID number, and location) in the logbook. Note field conditions, unusual circumstances, and weather conditions.

B. Fill out information on the sample identification label and attach the label to a sample bottle.

C. Complete initial information required on data collection forms.

3.3. Operation

3.3.1. Logbook

Enter all information pertinent to a field activity in a bound logbook with consecutively numbered pages. Enter information that does not require data entry into the logbook. If not included on a data collection form, entries in the logbook should include at least the information listed below.

- Date and time of entry
- Purpose of sampling
- Name and address of field contact
- Site identification
- Type of process producing waste (if known)
- Type of waste (sludge or wastewater)
- Description of sample waste components and concentrations
- Sample identifier and size of sample taken
- Description of sampling point
- Date and time for collection of sample
- Collector's sample identification number(s) and/or name
- References of the sampling site (like maps or photographs)
- Field observations and sampling locations
- Associated field measurements

- Method of sample collection, preservation techniques, and any deviations or anomalies noted

- Transfer of a logbook to individuals designated for specific tasks of the project

- Any uncompleted work

Because sampling situations vary widely, make notes as descriptive and inclusive as possible. A person reading the entries should be able to reconstruct the sampling situation from the recorded information. Use language that is objective, factual, and free of personal feelings or any other inappropriate terminology. If anyone other than the person to whom the logbook was assigned makes an entry, he/she should date and sign the entry. Never remove logbook pages. If a mistake is made, draw a single line through the mistake, write the new information above the line, and date and initial the change.

3.3.2. Photographs

Photographs provide the most accurate record of the field worker's observations. However, security restrictions may prohibit the use of cameras. Check with security prior to bringing a camera on-site. Photographs (when available) can be useful during future inspections, informal meetings, and hearings. A photograph must be documented to be a valid representation of an existing situation. For each photograph taken, record the items listed below in the logbook and on the back of each processed photograph.

- Date and time

- Signature of photographer

- Name and identification number of site

- Type of camera, lens, f-stop, shutter speed, and film used

- General direction faced and description of the subject

- Distance from photographer to object

- Location at the site

- Sequential number of photograph and the roll number

Any remarks about the contents of a photograph could jeopardize its value as legal evidence, so limit comments to the photograph's location. Photographs should be taken with a perspective similar to that afforded by the naked eye.

3.3.3. Sample Labels

Use soil and water sample identification labels to tag or label sample containers. Seal each sample immediately after it is collected and labeled with waterproof black ink. Label tags may be filled out before collection to minimize the handling of the sample containers. Appendix 5.1, Soil Sample and Water Sample Identification Labels, provides examples of the common sample labels to be used. Instructions for completing the labels are included in Appendix 1.3, Data Form Completion.

When appropriate, use an etching tool to mark sample containers in the field, rather than immediately applying a sample label or tag. This avoids possible label contamination problems and subsequent decontamination difficulties. In this case, write the data intended for the sample label in the logbook and transcribe them onto the label after the sample containers have been decontaminated.

Firmly attach the labels to the sample containers. The containers must be dry enough for gummed labels to be securely attached.

3.3.4. <u>Sample Collection and Inventory</u>

The number of persons involved in collecting and handling samples should be kept to a minimum. Use the guidelines established in this SOP and SOP 1.5, Guide to the Handling, Packaging, and Shipping of Samples. Complete data collection forms at the time the sample is collected and have the sample collector(s) sign or initial them. Include the date and time. On liquid containers, mark the liquid level with waterproof black ink. This requirement is not necessary for completely filled volatile organics analysis (VOA) septum vials. If the volume received by the laboratory is different than when collected, the sample container may have leaked, been tampered with, or spilled hazardous materials. Use the Custody Transfer Record/Lab Work Request form, Appendix 5.2, to inventory all samples collected in the field. Instructions for the form are in Appendix 5.3, Data Form Completion.

3.3.5. <u>Chain of Custody</u>

A. Objectives

The primary objective of the chain-of-custody procedure is to create an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and introduction as evidence. A sample is in someone's custody when one of the criteria listed below has been satisfied.

1. The sample is in one's actual possession.

2. The sample is in one's view after being in one's physical possession.

3. The sample is in one's physical possession and is then locked up so that no one can tamper with it.

4. The sample is kept in a secured area that is restricted to authorized personnel.

B. Transfer of Custody and Shipment

When transferring the samples, the transferee should sign and record the date and time on the Custody Transfer Record/Lab Work Request form. Custody transfers made to a sample custodian in the field should account for each sample, although samples may be transferred as a group. Every person who takes custody should fill in the appropriate section of the Custody Transfer Record/Lab Work Request form.

The field sampler is responsible for properly packaging and dispatching samples to the appropriate laboratory. This responsibility includes filling out, dating, and signing the appropriate portion of the Custody Transfer Record/Lab Work Request form.

Send all packages to the laboratory with the custody record and other pertinent forms. Retain a copy of these forms at the originating office (either carbon or photocopy). Packages sent via U.S. Mail, use registered mail with return receipt requested. For packages sent by common carrier, retain receipts as part of the permanent chain-of-custody documentation. Pack samples so that they do not break in shipment. Seal or lock the package so that any tampering can be readily detected. SOP 1.5, Guide to the Handling, Packaging, and Shipping of Samples, describes these procedures in detail.

3.4. Postoperation

3.4.1. Field

A. Verify that all sample bottles have been correctly identified and labels have all necessary information (location, time, and date).

B. Cross-check filled sample bottles in possession against those recorded in the logbook. Maintain custody of filled sample bottles by keeping them in actual possession, within view, locked or sealed up to prevent tampering, or bringing them into a secure area.

C. Prepare samples for transport according to SOP 1.3, Sample Control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

3.4.2. Documentation

A. Record data and any uncompleted work in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Document the chain of custody on the Custody Transfer Record/Lab Work Request form.

D. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

4. SOURCE

EPA. 1986. "RCRA Ground-water Monitoring Technical Enforcement Guidance Document." U.S. Environmental Protection Agency document. Washington, D.C.: U.S. Government Printing Office.

5. APPENDIXES

5.1. Sample Identification Label

5.2. Custody Transfer Record/Lab Work Request Form

5.3. Data Form Completion

APPENDIX 5.1

SAMPLE IDENTIFICATION LABELS

LOCATION ______________________ DATE ____________

SAMPLE NO. ______________________ TIME ____________

COMMENTS ______________________ SAMPLERS ____________

ANALYSIS REQUESTED:

PRESERVATIVE ____________

APPENDIX 5.2

CUSTODY TRANSFER RECORD/LAB WORK REQUEST FORM

WESTON

Custody Transfer Record/Lab Work Request

WESTON Analytics Use Only

Client ______

Work Order ______

Date Rec'd. ______ Date Due ______

RFW Contact ______

Client Contact/Phone ______

		Refrigerator#									
		#/Type Container									
		Containers/Volume									
		Preservative									
		ANALYSES REQUESTED ➡									
WA Use Only Lab ID	Client ID/Description	Matrix	Date Collected								

Matrix:
S - Soil
SE - Sediment
SO - Solid
W - Water
O - Oil
A - Air
DS - Drum Solids
DL - Drum Liquids
F - Fish
X - Other

Special Instructions:

Item/Reason	Relinquished by	Received by	Date	Time	Item/Reason	Relinquished by	Received by	Date	Time

WESTON Analytics Use Only

Samples Were:
1 Shipped or Hand Delivered
NOTES:

2 Ambient or Chilled
NOTES:

3 Received Broken/Leaking (Improperly Sealed)
Y N
NOTES:

4 Properly Preserved
Y N
NOTES:

5 Received Within Holding Times
Y N
NOTES:

COC Tape Was:
1 Present on Outer Package Y N
2 Unbroken on Outer Package Y N
3 Present on Sample Y N
4 Unbroken on Sample Y N
NOTES:

COC Record Was:
1 Present Upon Receipt of Samples Y N

Discrepancies Between Sample Labels and COC Record? Y N
NOTES:

RFW 21 21 001/A 5/88

7-115

APPENDIX 5.3

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

SAMPLE IDENTIFICATION LABEL

1. Location. Name of facility.

2. Sample No. Sample identification number.

3. Date. Date that sample was collected.

4. Time. Military time that sample was collected.

5. Samplers. Initials of crew members obtaining samples.

6. Analysis. Requested analysis to be reported by laboratory.

7. Preservatives. Type of preservative used.

8. Comments. Any additional information.

APPENDIX 5.3, Continued

CUSTODY TRANSFER/LAB WORK REQUEST FORM

1. Client. Client name.

2. Work Order. Work order number.

3. Date Received. Completed by lab.

4. Date Due. Data analysis is due from the laboratory.

5. RFW Contact. Laboratory contact.

6. Client Contact/Phone. Person (and their phone number) who will be laboratory contact.

7. Client ID/Description. Sample ID and any descriptive information about the sample.

8. Matrix. Matrix type for sample; see valid matrix codes on lower half of form.

9. Date Collected. Date the sample was collected.

10. Container/Preservative. Container size and type (500-ml glass).

11. Analysis Requested. The type of analysis requested for each sample. The column heading indicating the type.

    PCB = Polychlorinated Biphenyl

    HE = High Explosive

    TCL = Target Compound

    EPTOX = Extraction Procedure Toxicity

    VOA = Volatile Organic Analysis

    BNA = Base Neutral Acid

    TCLD = Toxic Characterization Leach Procedure

    PEST = Pesticides

    MAJ = Major Cation/Anion

12. Matrix. Valid matrix codes. (See Form)

CUSTODY TRANSFER/LAB WORK REQUEST FORM

13. Special Instructions. Any special instructions.

14. Items/Reason. The reason the custody is transferred for all or selected items of the shipment.

15. Relinquished By. Signature of person sending samples.

16. Received By. Person or (shipping company) who received samples.

17. Date. Date sample is sent.

18. Time. Military time sample is sent.

STANDARD OPERATING PROCEDURE 1.4

SAMPLE CONTAINERS AND PRESERVATION

1. PURPOSE

To provide guidance in the selection of suitable containers for samples, container cleaning, required sample volumes, sample collection, holding times, and the recommended preservation techniques for water, wastes, sediments, sludges and soil samples.

2. GENERAL DISCUSSION

The Remedial Investigation Plan (RIP) provides information about the scope and details of a given operation and establishes the number, types, and analyses of field samples (including field analyses). Refer to the RIP for the procedures and equipment to be used in collecting samples. Collection and measurement of samples and the documentation of data will be performed as described in the associated procedures.

In choosing a sample container, the ideal material should be nonreactive with the sample and the particular analytical parameter to be tested. Glass or Teflon containers must be used with samples analyzed for organic compounds to prevent the introduction of extraneous organic compounds, such as those that might be leached from plastic containers. The rigid plastic screw caps for the bottles must be Teflon lined to prevent contamination.

Once a sample has been collected, steps must be taken to preserve the sample's chemical and physical integrity during transport and storage before analysis is conducted. The type of sample preservation required will vary according to the sample type and the parameter to be measured.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information on equipment and supplies; sample collection, preservation, packaging, and shipping; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.3	Sample Control and Documentation
1.5	Guide to the Handling, Packaging, and Shipping of Samples
1.6	General Equipment Decontamination
2.8	Sampling for Volatile Organics

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

F. Contact the carrier that will transport samples to obtain information on regulations and specifications.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Sample Container Preparation

Sample containers will vary according to the matrix and nature of the sample to be collected. Wide-mouth containers are generally used for soils and wastes; narrow-mouth containers are used for water. Calculations should be made to determine the number and type of containers required for the sampling effort.

Procurement of containers should be initiated as early as possible to avoid unavailability and shipping delays and to satisfy cleaning requirements. Obtain the required number of sample bottles included in the RIP of a type consistent with recommendations in EPA-600/4-79-020 (EPA 1979). Sample containers can usually be obtained directly from the laboratory performing the analyses.

A. Container Type

1. Identify the containers required for analysis by matrix as shown in Appendixes 5.2 through 5.7 (for example, amber glass, narrow-mouth bottles for PCB analysis of water samples).

2. Calculate the number of each type of container required by including duplicates and blanks with the number of investigative samples specified in the RIP.

B. Container Cleaning

Containers precleaned to EPA specifications may be obtained from suppliers at additional cost. If obtained as is, follow procedures outlined below to wash containers and caps. The person washing containers must wear gloves.

1. Inorganic and general parameters

   a. Wash containers, septa or liners, and closures in hot tap water with laboratory-grade, nonphosphate detergent.

   b. Rinse three times with tap water.

   c. Rinse three times with ASTM Type 1 deionized water.

   d. Oven dry containers, septa or liners, and closures.

   e. Remove containers, septa or liners, and closures from oven.

   f. Place liners in closures (Teflon side down) and place on containers. Containers should not be removed from the preparation room until sealed.

2. Trace metals

   For certain parameters, a special cleaning procedure is needed to avoid adsorption or contamination resulting from interaction with container walls. These procedures are outlined below.

   a. Wash containers, closures, and Teflon liners in hot tap water with laboratory-grade, nonphosphate detergent.

   b. Rinse three times with tap water.

   c. Rinse one time with 1:1 nitric acid.

   d. Rinse three times with ASTM Type 1 deionized water.

   e. Air dry in a contaminant-free environment.

   f. Place liners in closures and place closures on containers. Containers should not be removed from the preparation room until sealed.

3. Organics

   a. Wash containers, closures, and Teflon liners in hot tap water with laboratory-grade, nonphosphate detergent.

   b. Rinse three times with tap water.

   c. Rinse one time with 1:1 nitric acid.

   d. Rinse three times with ASTM Type 1 deionized water.

   e. Rinse one time with pesticide-grade methylene chloride.

f. Oven dry.

g. Remove containers, closures, and Teflon liners from oven.

h. Place Teflon liners in closures and place closures on container. Do not remove containers from preparation area until sealed.

4. Sterilization

a. For microbiological analyses, sterilize the container and its stopper/cap by autoclaving at 121°C for 15 min or by dry heat at 180°C for 2 hrs. Heat-sensitive plastic bottles may be sterilized with ethylene oxide at low temperatures.

b. The sample bottles can be wrapped with aluminum foil before sterilization. Remove the protective wrapping after the sample is taken to facilitate cleaning the bottle before shipment to the analytical laboratory.

c. An acceptable alternative for emergency or field use is the sterilization of containers by boiling in water for 15 min.

3.2.4. Sample Volume

The volume of sample collected should be sufficient to perform all the required analyses plus an additional amount to provide for any quality control needs, split samples, or repeat examination. The volumes listed in Appendixes 5.2 through 5.7 are intended as general guidelines. The laboratory receiving the sample should be consulted for specific volume requirements, and these should be specified in the RIP.

NOTE: A sufficient number of containers must be available to ship the proper sample volume. For example, Department of Transportation (DOT) and International Air Transport Association (IATA) regulations limit the size of a sample container to 16 oz if the contents may include hazardous materials. In this case, two 500-ml or four 250-ml containers would be required to ship a one-liter fluid sample. See SOP 1.5, Guide to the Handling, Packaging, and Shipping of samples for additional information.

3.2.5. Sample Preservation

Sample containers may arrive at the site with the proper type and amount of preservatives in them. If onsite preservation of the samples is necessary, the proper reagents should be provided for the field crew in an easily usable form that can be added at the time of sampling. Preservation required for the specific analyses requested may be determined by using Appendixes 5.2 through 5.7. Materials commonly needed for sample preservation are listed below.

1. Small bottles of pelletized NaOH

2. Ascorbic acid crystals

3. Lead acetate paper and pH paper

4. Calibrated sampling scoops

5. Reagent-grade acids (HNO_3, HCl, and H_2SO_4) in Safe-Kote bottles

6. Calibrated dispenser bottles (0.5 to 2 ml) for acids.

3.2.6. Field

The appropriate number and type of precleaned containers, along with preservatives, equipment, and packaging containers, should be stored in a facility that can be locked or guarded. The storage facility should be located near the site and decontamination staging area, but should also be accessible to freight trucks that will be delivering new container shipments and transporting samples to the laboratory.

3.3. Operation

A. Soils/Wastes Sample Collection

NOTE: All individuals in the sampling area must wear gloves appropriate to their tasks. Only the persons collecting samples and filling sample containers must discard their gloves between sampling locations.

1. While wearing protective gloves, fill the bottle with the sample. Wet soils should have enough headspace to allow for expansion.

2. Take extreme care to avoid contamination of the bottles or caps. Remove the cap just before filling and replace it as soon as possible after filling. Avoid any personal contact with the inside of the bottle or cap.

3. Clean the exterior of the bottle with a wipe moistened with deionized water. When appropriate, implement SOP 1.6, General Equipment Decontamination. Attach a completed sample label (according to SOP 1.3, Sample Control and Documentation) and cover with clear tape. The tape should extend at least 1/4 inch beyond the edges of the label.

4. Preservation of soil samples is usually accomplished by protecting the sample from UV light by using an amber bottle and keeping the sample cool.

5. If required, place the container in a cooler. Maintain the samples at a cool temperature with frozen packaged ice (for example, Blue Ice) or ice cubes sealed in two plastic bags. Avoid freezing the sample by packing as to prevent contact between the coolant and the sample container.

6. If samples are not delivered to the laboratory on a daily basis, check ice chests and insulated boxes every 24 hrs and replace thawed ice or Blue Ice packs as needed.

7. Avoid exposing the sample to extreme hot or cold temperatures and intense sunlight, even if no specific preservation is recommended.

8. EPA guidance recommends that a 4°C temperature be maintained in the sample container before and during shipment. The temperature in the packed container should be confirmed to be 4°C before the samples are

shipped. A temperature reading from the middle of the package near the containers is satisfactory for this purpose.

The temperature should be checked again at the analytical laboratory. Record both temperatures in the special instructions section of the Custody Transfer Record/Lab Work Request form (see SOP 1.3., Sample Control and Documentation). If a continuous temperature record can be obtained during the shipment period, record the maximum temperature in the container on the custody transfer form.

B. Water Sample Collection

NOTE: All individuals in the sampling area must wear gloves appropriate to their tasks. Only the persons collecting samples and filling sample containers must discard their gloves between sampling tasks.

1. Before collecting samples for organics and CN, use the Hach Test Kit for residual chlorine and sulfides. If present, preserve samples according to instructions in Appendix 5.2, Recommendation for Sampling and Preservation of Water Samples According to Measurement (for example, $Na_2S_2O_3$ to organic samples).

2. Collect samples directly in the appropriate container.

3. Do <u>not</u> filter unless specified in the Sampling Plan.

4. Do <u>not</u> rinse the container.

5. Slowly fill each container almost full, except VOAs (see SOP 2.8, Sampling for Volatile Organics).

6. Add any prescribed preservative.

7. Cap the container, shake, and reopen it.

8. If using acid or base preservative, check the pH adjustment with pH paper.

9. If necessary, add more preservative.

10. Complete steps 3 and 5-8 from Section 3.3.A.

11. If an error was made in collection, discard the entire bottle and start with a new one.

C. Holding Time

In general, analyze samples as soon as possible after collection. Some parameters are required to be analyzed in the field (See Appendix 5.2). Allowable holding times are listed as guidelines. They represent the maximum times that samples are considered valid. There are instructions in the RIP for delivering the samples to the laboratory as soon as possible. (See SOP 1.5, Guide to the Handling, Packaging, and Shipping of Samples).

3.4. Postoperation

3.4.1. Field

A. Store unused, clean sample bottles in a clean environment for later use.

B. Clean acid dispensers and store them dry for the next field operation.

C. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

D. Restore the site to presampling conditions as specified in the RIP.

E. Make sure all wells are labeled, sampling locations are properly staked, and the location ID is readily visible on the guard pipe or location stake.

F. Prepare samples for transport according to SOP 1.3, Sample Control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

3.4.2. Documentation

A. Record any cleanup procedures and any uncompleted work (like site restoration or uncompleted sampling) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

4. SOURCES

Korte, Nic, and Peter Kearl. 1985. "Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: Second Edition." U.S. Department of Energy report GJ/TMC-08. Technical Measurements Center, Grand Junction Project Office, Grand Junction, Colorado.

EPA. 1982. "Handbook for Sampling and Sample Preservation of Water and Wastewater." U.S. Environmental Protection Agency report EPA-600/4-82-029. Washington, D.C.: U.S. Government Printing Office.

EPA. 1983. "Methods for Chemical Analysis of Water and Wastes." U.S. Environmental Protection Agency report EPA-600/4-79-020. Washington, D.C.: U.S. Government Printing Office.

EPA. 1983. "Manual of Groundwater Quality Sampling Procedures." U.S. Environmental Protection Agency report EPA/600/2-81-160. Washington, D.C.: U.S. Government Printing Office.

EPA. 1984. "Test Methods for Evaluation of Solid Waste." 2d ed. U.S. Environmental Protection Agency report EPA-SW-846. Washington, D.C.: U.S. Government Printing Office.

EPA. 1985. "Practical Guide for Groundwater Sampling." U.S. Environmental Protection Agency report EPA/600/2-85/104. Washington, D.C.: U.S. Government Printing Office.

EPA. 1986. "RCRA Groundwater Monitoring Technical Enforcement Guidance Document." U.S. Environmental Protection Agency document OSWER-9950.1. Washington, D.C.: U.S. Government Printing Office.

5. APPENDIXES

5.1. Equipment and Supplies Checklist

5.2. Recommendation for Sampling and Preservation of Water Samples According to Measurement

5.3. Sampling and Preservation Procedures for RCRA Groundwater Detection Monitoring

5.4. Analysis Plan for Soil/Sediment Samples

5.5. Sample Containers for Waste

5.6. Containers for Aqueous Waste Samples

5.7. Analysis Plan for Soil/Sediment/Waste Samples

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Narrow-mouth amber glass bottles with Teflon-lined caps (0.5, 1, and 2 liters)
- ________ Amber glass vials with Teflon septa (40-ml)
- ________ Blue Ice or equivalent
- ________ 250-ml sterile bottle
- ________ Cardboard boxes
- ________ Insulated coolers
- ________ Ballpoint pen (permanent black ink)
- ________ Felt-tip marker pen (permanent black ink)
- ________ Heavy-duty poly bags and ties
- ________ Strapping tape
- ________ Wide-mouth polyethylene bottles (0.5, 1, and 2 liters)
- ________ Plastic trashcan liners
- ________ 1-11 pH indicator paper
- ________ Canvas bags
- ________ Hach field test kit for sulfides
- ________ Hach field test kit for chlorine
- ________ Parafilm
- ________ Ascorbic acid crystals
- ________ Disposable surgical gloves (latex, PVC, other suitable plastic, or rubber)
- ________ NaOH pellets
- ________ Disposable wipes
- ________ Crystalline $Na_2S_2O_3$
- ________ Methanol and deionized water in Teflon wash bottles

APPENDIX 5.1, Concluded

EQUIPMENT AND SUPPLIES CHECKLIST

________ Padding for packaging of samples

________ Concentrated HNO_3, H_2SO_4, and HCl

________ New or cleaned polyethylene narrow-mouth bottles (1.0 liter, 500 ml, 125 ml, and 60 ml)

APPENDIX 5.2

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF WATER SAMPLES ACCORDING TO ANALYSIS[1]

Measurement	Volume Requirement (millileter)	Container[2]	Preservative[3,4]	Holding Time[5]
Physical Properties				
Color	50	P,G	Ice	48 Hrs.
Conductance	100	P,G	Ice	28 Days
Hardness	100	P,G	HNO_3 to pH<2	6 Mos.
Odor	200	G only	Ice	24 Hrs.
pH	25	P,G	None Required	Analyze Immediately
Residue				
Filterable	100	P,G	Ice	7 Days
Nonfilterable	100	P,G	Ice	7 Days
Total	100	P.G	Ice	7 Days
Volatile	100	P,G	Ice	7 Days
Settleable Matter	1000	P,G	Ice	48 Hrs.
Temperature	1000	P,G	None Required	Analyze Immediately
Turbidity	100	P,G	Ice	48 Hrs.
Metals				
Dissolved	200	P,G	Filter onsite HNO_3 to pH<2	6 Mos. 6 Mos.[8]
Suspended	200	P,G	Filter onsite	6 Mos.
Total	100	P,G	HNO_3 to pH<2	6 Mos.
Chromium^{+6}	200	P,G	Ice	48 Hrs.

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF WATER SAMPLES ACCORDING TO ANALYSIS(1)

Measurement	Volume Requirement (millileter)	Container[2]	Preservative[3,4]	Holding Time[5]
Dissolved Oxygen				
Probe	300	G bottle and top	None Required	Analyze Immediately
Winkler	300	G bottle and top and store in dark	Fix onsite	8 Hours
Phosphorus				
Orthophosphate, Dissolved	50	P,G	Filter onsite Ice	48 Hrs.
Hydrolyzable	50	P,G	Ice H_2SO_4 to pH<2	28 Days
Total, Dissolved	50	P,G	Filter on site Ice H_2SO_4 to pH<2	24 Hrs.
Silicia	50	P only	Ice	28 Days
Sulfate	50	P,G	Ice	28 Days
Sulfide	50	P,G	Ice add 2 m liter zinc acetate plus NaOH to pH >9	7 Days
Sulfite	50	P,G	None Required	Analyze Immediately
Organics				
BOD	1000	P,G	Ice	48 Hrs.
COD	50	P,G	Ice H_2SO_4 to pH<2	28 Days

APPENDIX 5.2, Continued

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF WATER SAMPLES ACCORDING TO ANALYSIS[1]

Measurement	Volume Requirement (milliliter)	Container[2]	Preservative[3,4]	Holding Time[5]
Mercury				
Dissolved	100	P,G	Filter HNO_3 to pH<2	28 Days
Total	100	P,G	HNO_3 to pH<2	28 Days
Inorganics, Nonmetallics				
Acidity	100	P,G	Ice	14 Days
Alkalinity	100	P,G	Ice	14 Days
Bromide	100	P,G	None Required	28 Days
Chloride	50	P,G	None Required	28 Days
Chlorine	200	P,G	None Required	Analyze Immediately
Cyanides	500	P,G	None Required	28 Days
Fluoride	300	P,G	Ice	28 Days
Iodide	100	P,G	Ice	24 Hrs.
Nitrogen				
Ammonia	400	P,G	Ice H_2SO_4 to pH<2	28 Days
Kjeldahl, Total	500	P,G	Ice H_2SO_4 to pH<2	28 Days
Nitrate Plus Nitrite	100	P,G	Ice H_2SO_4 to pH<2	28 Days
Nitrate[9]	100	P,G	Ice	48 Hrs.
Nitrite	50	P,G	Ice	48 Hrs.

APPENDIX 5.2, Continued

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF WATER SAMPLES ACCORDING TO ANALYSIS(1)

Measurement	Volume Requirement (milliliter)	Container[2]	Preservative[3,4]	Holding Time[5]
Organic Carbon	25	P,G	Ice H_2SO_4 or HCl to pH<2	28 Days
Phenolics	500	G only	Ice H_2SO_4 to pH<2	28 Days
Cyanide	1000	P,G	Ice 40% NaOH to pH>12, 0.6 g Ascorbic Acid	14 Days
Coliform, Fecal and Total	250	P,G	Ice Sterile	6 Hrs.
Oil and Grease	1000	G	Ice H_2SO_4 to pH<2	28 Days
Organic Carbon	25	P,G	Ice H_2SO_4 to pH<2	28 Days
Phenols	1000	G, Teflon-lined Cap	Ice	7 Days until extraction; 40 Days after extraction
Total Organic Halogen and Purgeable aromatics	40	G, Teflon-lined vial septum	Ice 0.008% $Na_2S_2O_3$[6]	14 Days
Purgeable aromatics	40 vial	G, Teflon-lined septum	Ice 0.008% $Na_2S_2O_3$[6]	14 Days
Acrolein and acrylonitrile	1000	G, Teflon-lined septum	Ice 0.008% $Na_2S_2O_3$[6]	14 Days
Phenols	1000	Teflon-lined cap	Ice 0.008% $Na_2S_2O_3$[6]	7 days until extraction; 40 days after extraction

APPENDIX 5.2, Continued

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF WATER SAMPLES ACCORDING TO ANALYSIS(1)

Measurement	Volume Requirement (millileter)	Container[2]	Preservative[3,4]	Holding Time[5]
Benzindines	1000	G, Teflon-lined cap	Ice 0.008% $Na_2S_2O_3$[6]	7 Days until extraction; 40 days after extraction
Phthalate esters	1000	G, Teflon-lined cap	Ice 0.008% $Na_2S_2O_3$[6]	7 Days until extraction; 40 days after extraction
Nitrosamines	1000	G, Teflon-lined cap	Ice store in dark 0.008% $Na_2S_2O_3$[6] extraction	7 Days until extraction; 40 days after
Nitroaromatics and isophorone	1000	G, Teflon-lined cap	Ice	7 days until extraction; 40 days after extraction
Polynuclear aromatic hydrocarbons	1000	G, Teflon-lined cap	Ice	7 days until extraction; 40 days after extraction
Haloethers	1000	G, Teflon-lined cap	Ice	7 days until extraction; 40 days after extraction
Chlorinated	1000	Teflon-lined cap	Ice	7 days until extraction; 40 days after extraction
TCDD	1000	G, Teflon-lined cap	Ice	7 days until extraction; 40 days after extraction

APPENDIX 5.2, Continued

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF WATER SAMPLES ACCORDING TO ANALYSIS[1]

Measurement	Volume Requirement (millileter)	Container[2]	Preservative[3,4]	Holding Time[5]
Pesticides Tests				
Pesticides	1000	G, Teflon-lined cap	Ice	7 days until extraction; 40 days after extraction
Radiological Tests				
Alpha, beta and radium	1000	P,G	HNO_3 to pH<2	6 mos.
Tritium	25	G	None	No limit
Isotopic Uranium	500	P	HNO_3 to pH<2	6 mos.
Sr-90	1000	P	HNO_3 to pH<2	6 mos.

[1]More specific instructions for preservation and sampling are found with each procedure described in this manual. A general discussion about sampling water and industrial wastewater may be found as ASTM, Part 31, p. 72-82 (1976) Method D-3370.

[2]Plastic (P) or Glass (G). For metals, polyethylene with a polypropylene cap (no liner) is preferred.

[3]Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When use of an automated sample makes it impossible to preserve each aliquot, then samples may be preserved by keeping cool at 4°C until compositing and sample splitting is completed.

[4]When any sample is to be shipped by common carrier or sent through the United States mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering material for transportation is responsible for ensuring compliance. For the preservation requirements of Table 1, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following material: Hydrochloric acid (HCL) in water solutions at concentrations of 0.080% by weight or less, pH about 12.30 or less.

[5]Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time and has received a variance from the regional administrator. Some samples may not be stable for a shorter time, if knowledge exists to show it is necessary to maintain sample stability.

[6]Should only be used in the presence of residual chlorine.

[7]Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before the pH adjustment in order to determine if sulfide is present. If sulfide is present, it can be removed by

RECOMMENDATION FOR SAMPLING AND PRESERVATION OF WATER SAMPLES ACCORDING TO ANALYSIS[1]

the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

[8]Samples should be filtered immediately onsite before adding preservative for dissolved metals.

[9]For samples from nonchlorinated drinking water supplies, concentrated H_2SO_4 should be added to lower sample pH to less than 2. The sample should be analyzed within 14 days.

APPENDIX 5.3

SAMPLING AND PRESERVATION PROCEDURES FOR RCRA GROUNDWATER DETECTION MONITORING[a]

Parameter	Recommended Container[b]	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis
		Indicators of Groundwater Contamination[c]		
pH	T,P,G	Field determined	None	25 m liter
Specific conductance	T,P,G	Field determine	None	100 m liter
TOC	G, amber, T-lined cap[e]	Ice	28 days HCl to pH<2	4 x 15 m liter
TOX	G, amber, T-lined septa or caps	Ice, add 1.1M sodium sulfite	7 days	4 x 15 m liter
		Groundwater Quality Characteristics		
Chloride	T, P, G	Ice	28 days	50 m liter
Iron Manganese Sodium	T, P	Field acidified to pH <2 with HNO_3	6 months	200 m liter
Phenols	G	Ice/H_2SO_4 to pH <2	28 days	500 m liter
Sulfate	T, P, G	Ice	28 days	50 m liter
		EPA Interim Drinking Water Characteristics		
Arsenic Barium Cadmium Chromium Lead Mercury Selenium Silver	T, P	Total Metals Field acidified to pH <2 with HNO_3 Dissolved Metals 1. Field filtration (0.45 micron) 2. Acidify to pH <2 with HNO_3	6 months 6 months	1000 m liter 1000 m liter

APPENDIX 5.3, Continued

SAMPLING AND PRESERVATION PROCEDURES FOR RCRA GROUNDWATER DETECTION MONITORING[a]

Parameter	Recommended Container[b]	Preservative	Maximum Holding Time	Minimum Volume Required for Analysis
Fluoride	T, P	Ice	28 days	300 m liter
Nitrate/ Nitrite	T, P, G	Ice/H_2SO_4 to pH <2	14 days	1000 m liter
Endrin Lindane Methoxychlor Toxaphene 2,4 D 2,4,5 TP Silvex	T, G	Ice	7 days	2000 m liter
Radium Gross Alpha Gross Beta	P, G	Field acidified to pH <2 with HNO_3	6 months	1 gallon
Coliform bacteria	PP, G (sterilized)	Ice	6 hours	200 m liter
		Other Groundwater Characteristics of Interest		
Cyanide	P, G	Ice, NaOH to pH >12. 0.6 g ascorbic acid[f]	14 days[9]	500 m liter
Oil and Grease	G only	Ice H_2SO_4 to pH <2	28 days	100 m liter
Semivolatile, nonvolatile organics	T, G	Ice	14 days	60 m liter
Volatiles	G, T-lined	Ice	14 days	60 m liter

[a]References:

Test Methods for Evaluation Solid Waste - Physical/Chemical Methods, SW-846 (2nd edition, 1982).

Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020.

Standard Methods for the Examination of Water and Wastewater, 16th edition (1985).

SAMPLING AND PRESERVATION PROCEDURES FOR RCRA GROUNDWATER DETECTION MONITORING[a]

[b]Container Types:

P = Plastic (polyethylene)
G = Glass
T = Fluorocarbon resins (PTFE, Teflon, FEP and PFA)
PP = Polypropylene

[c]Based on the requirements for detection monitoring (265.93), the owner/operator must collect a sufficient volume of groundwater to allow for the analysis of four separate replicates.

[d]Shipping containers (cooling chest with ice or ice pack) should be certified as to the 4°C temperature at the time of sample placement into these containers. Preservation of samples requires that the temperature of collected samples be adjusted to 4°C and maintained at 4°C upon placement of sample and during shipment. Field personnel will check the temperature in the container at the time of shipping and ice the samples to maintain a cool temperature during shipment. Maximum-minimum thermometers can be placed into the shipping chest to record temperature history. Chain-of-custody forms will include the temperature in the container at the time of shipment and delivery at the laboratory in addition to in-transit (maximum) temperature, if available.

[e]Do not allow any headspace in the container.

[f]Use ascorbic acid only in the presence of oxidizing agents.

[g]Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before the pH adjustment in order to determine if sulfide is present. If sulfide is present, it can be removed by addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

APPENDIX 5.4

ANALYSIS PLAN FOR SOIL/SEDIMENT SAMPLES

Analyte	Method	Sample Container	Sample Volume (g)	Holding Preservations	Time (days)
Volatile Organics	Ref. 2	40-ml vial (2) w/Teflon-lined silicon rubber septum	5	Ice	14
Base/Neutral/Acid Extractable Organics	Ref. 3	Amber G, 1 L	10-30	Ice	7/40[2]
Organochlorine Pesticide/PCB	Ref. 4	Amber G, 1 L	10-30	Ice	7/40[2]
HSL Inorganic[1]	Ref. 5	P, G, 1 L	200	Ice	180
Non-HSL Metals	SW-846	P, G, 1 L	200	Ice	180
Reactivity	Ref. 6	Amber G	---	Ice	N/A
Chloride	EPA 300.0[3]	G, 1 L	20	Ice	N/A
Sulfate	EPA 300.0[3]	G, 1 L	20	Ice	N/A
Nitrate	EPA 300.0[3]	G, 1 L	20	Ice	N/A
Cyanide	Ref. 1	G, 1 L	200	Ice	14
Hexavalent Chromium	S.M. 312b[4]	G, 1 L	100	Ice	1

[1]Includes cesium, molybdenum, and strontium, which are non-HSL metals, but are analyzed using the same methods.

[2]Extract within 7 days; analysis within 40 days of extraction.

[3]Soil/sediments will be leached with Laboratory Reagent Water (20 g soil to 50 ml water) and water extract analyzed using procedure in "Methods for Chemical Analysis of Water and Wastes," 1983; EPA 600/4-79-020.

[4]Soil/sediment will be leached with Laboratory Reagent Water (5 g soil and 100 ml of water) by shaking for 2 hours, and the water extract filtered and subsequently analyzed. This is in accordance with method 312B in Standard Methods for Examination of Water and Wastewater, 16th Edition.

*The RIP Sampling Plans will define the actual suite of parameters to be analyzed for specific samples.

APPENDIX 5.4, Concluded

ANALYSIS PLAN FOR SOIL/SEDIMENT SAMPLES

Method References

Ref. 1. Method 9010 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 2. Method 8240 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 3. Method 8270 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington DC 20460, Revised September 1986.

Ref. 4. Method 8080 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 5. Method 6010 or 7000 Series Methods - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 6. Method 9010, 9030 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 7. Method 1310 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

APPENDIX 5.5

SAMPLE CONTAINERS FOR WASTE

Waste Type	Recommended Container	Closure	Analysis
Photosensitive wastes 1000 or 2000 m liter	Amber HDPE or amber glass caps with Teflon liners for glass bottles	LPE caps for HDPE bottles; Bakelite	Waste characterization per 40 CFR-Part 261
Pesticide hydrocarbon chlorinated hydrocarbons petroleum distillates	Wide-mouth borosilicate glass bottles 1000 or 2000 m liter	Bakelite caps with Teflon liner	Waste characterization per 40 CFR-Part 261
Oil wastes	HDPE bottles wide mouth 1000 or 2000 m liter	LPE caps	Waste characterization per 40 CFR-Part 261
Strong aikali or hydrofluoric acid	HDPE bottles. 1000 m liter	LPE caps wide mouth	Waste characterization per 40 CFR-Part 261
Aqueous wastes--characterization of organics	Borosilicate glass bottles 1000 or 2000 m liter	Caps with Teflon liner	Waste characterization per 40 CFR-Part 261
Solids (sludge, soils, and granular)	8-oz, wide-mouth glass bottle	Bakelite caps with Teflon liners	Waste characterization per 40 CFR-Part 261

APPENDIX 5.6

CONTAINERS FOR AQUEOUS WASTE SAMPLES

Analyte	Sample Container	Sample Volume	Preservation[7]	Holding Time(days)
HSL Volatile	vial (2)	40 m liter	Ice	14
HSL Base/Neutral/Acid[1]	Amber G,	1 L	Ice	7/40[5]
HSL Pesticide/PCB	Amber G,	1 L	Ice	7/40
HSL Inorganic[2]	P,G,	1 L	pH<2,w/HNO_3[9]	180
Non-HSL Metals	P,G,	1 L	pH<2,w/HNO_3[9]	180
Cyanide	P,G,	0.5L	pH>11,w/NaOH	14
pH[3]	P,G	N/A	None	Field Meas.
Sp. Conductivity	P,G	N/A	None	Field Meas.
Temperature[3]	P,G	N/A	None	Field Meas.
Diss. Oxygen	G	N/A	None	Field Meas.
TDS	P,G	0.1 L	Ice	7
TSS	P,G	0.1 L	Ice	7
Total Phosphate	P,G,	1L	Ice, pH<2[9]	28
Chloride, Sulfate	P,G,	1 L	Ice	28
Carbonate/Bicarbonate[4]	P,G,	1 L	Ice	14
Nitrate	P,G,	1L	Ice	2
Hexavalent Chromium	P,G,	1 L	Ice	2

[1]The HSl Base/Neutral/Acid fractions analytical parameters are the HSL semivolatiles.
[2]Includes Cesium, Molybdenum, and Strontium, which are non-HSL metals, but are analyzed using the same methods.
[3]Field Measurements.
[4]These are reported as carbonate and biocarbonate alkalinity.
[5]Seven day to extraction; analysis within 40 days of extraction.
[6]All samples with the exception of those for total metals will be filtered within 4 hours of sample collection and preservatives added to the filtrate as specified.
[7]All samples will be kept at 4°C after arrival at the laboratory.
*The RIP Sampling Plans will define the actual suite of parameters to be analyzed for specific samples.

APPENDIX 5.7

ANALYSIS PLAN FOR SOIL/SEDIMENT/WASTE SAMPLES*

Analyte	Sample Container	Sample Mass	Preservations	Holding Time(days)
HSL Volatile	40 m liter vial (2)	5	Ice	14
HSL Base/Neutral/Acid[1]	Amber G, 1 L	10-30	Ice	7/40[3]
HSL Pesticide/PCB	Amber G, 1 L	10-30	Ice	7/40[3]
HSL Inorganic[2]	P,G, 1 L	200	Ice	180
Non-HSL Metals	P,G, 1L	200	Ice	180
Reactivity	Amber G	100	Ice	N/A
EP Toxicity	Amber G	100	Ice	N/A
Chloride	G, 1 L[4]	20	Ice	N/A
Sulfate	G, 1 L[4]	20	Ice	N/A
Nitrate	G, 1 L[4]	20	Ice	N/A
Cyanide	G, 1 L	200	Ice	14
Hexavalent Chromium	G, 1 L[5]	200	Ice	1

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[1]The HSI Base/Neutral/Acid fractions analytical parameters are the HSL semivolatiles.

[2]Includes Cesium, Molybdenum, and Strontium, which are non-HSL metals.

[3]Extract within 7 days; analysis within 40 days of extraction.

[4]Soil/sediments will be leached with laboratory reagent water (20 g soil to 50 m liter water) and water extract analyzed using referenced procedure. Procedure reference: Methods for Chemical Analysis of Water and Wastes, 1983; EPA 600/4-79-020.

[5]Soil/sediment will be leached with laboratory reagent water (5 g soil and 100 m liter of water) by shaking for 2 hours. The water extract is filtered and subsequently analyzed. This is in accordance with method 312B in Standard Methods for Examination of Water and Wastewater, 15th Edition.

*The RIP Sampling Plans will define the actual suite of parameters to be analyzed for specific samples.

APPENDIX 5.7, Concluded

ANALYSIS PLAN FOR SOIL/SEDIMENT/WASTE SAMPLES

Method References

Ref. 1. Method 9010 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 2. Method 8240 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 3. Method 8270 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 4. Method 8080 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 5. Method 6010 or 7000 Series Methods - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 6. Method 9010 or 9030 Series Methods - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

Ref. 7. Method 1310 - "Test Methods for Evaluating Solid Wastes," Office of Solid Waste and Emergency Response, Washington, DC 20460, Revised September 1986.

STANDARD OPERATING PROCEDURE 1.5

GUIDE TO THE HANDLING, PACKAGING, AND SHIPPING OF SAMPLES

1. PURPOSE

To provide a general guide for packaging and shipping samples of environmental and hazardous materials to the laboratory. In addition, instructions are provided to select the correct category for packaging and shipping samples of unknown contents.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information concerning the scope and details of a specific operation. Refer to the RIP for the type of samples to be collected and the destination for the samples. This SOP describes the procedures used by the ER Program technical assistance subcontractor when handling, packaging, and shipping samples. Other procedures or requirements used by installation subcontractors must conform to this SOP. The transportation of samples must protect the integrity of the sample and prevent any detrimental effects from the potentially hazardous nature of the samples.

Samples collected at a site are classified as environmental or hazardous material samples. In general, environmental samples are collected from streams, farm ponds, small lakes, wells, and offsite soils that are not expected to be contaminated with hazardous materials. Samples of onsite soils or water and materials collected from drums, bulk storage tanks, obviously contaminated ponds, impoundments, lagoons, pools, and leachates from hazardous waste sites are considered samples of hazardous materials. A distinction must be made between the two types of samples for two reasons.

1. The appropriate Department of Transportation (DOT) or International Air Transport Association (IATA) procedures for the transportation of samples must be determined. If there is any doubt, a sample should be considered hazardous and shipped accordingly.

2. The health and safety of laboratory personnel receiving samples must be protected. Special precautions are used at laboratories for samples that are hazardous material.

Hazardous materials defined by the transportation regulations contained in 49 CFR (Subchapter C, Part 171) or the current edition of IATA regulations for dangerous goods (Sections 3 and 4) should be shipped only by the method of transportation specified in these regulations. Employees should be aware that regulatory bodies with jurisdiction have the authority to levy substantial fines and penalties to violators. Failure on the part of any employee to follow the requirements of these procedures is cause for disciplinary action, including discharge.

Any questions about the instructions for shipping environmental samples or hazardous materials in this SOP should be directed to the subcontractor's health and safety officer, who provides technical assistance to the ER Program.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, SOPs 1.1-1.10 must be reviewed. These SOPs contain information on the performance of field activities. They should be consulted for specific information on equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation
1.4	Sample Containers and Preservation
1.6	General Equipment Decontamination

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

E. Contact the carrier that will transport samples to obtain information on regulations and specifications.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

C. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.3. Operation

Procedures for shipping samples under DOT and IATA regulations are provided in Appendices 5.1 through 5.4. Compliance with the following step-by-step procedure will ensure that all applicable requirements for classifying, packing, marking, labeling, and documenting samples will be met.

A. Determine the correct technical name or composition of substances that might be in the samples. Check to see if the substance is forbidden on aircraft. Section 1 of the IATA regulations for dangerous goods contains a list of the substances that cannot be transported by air.

B. All samples must be transported by cargo aircraft or land transport. Samples are not to be shipped by passenger aircraft. See Appendices 5.1 through 5.4 for the appropriate DOT and IATA requirements.

C. Consult the DOT or IATA references to select the appropriate shipping container and packing material.

D. Prepare the consignment according to applicable requirements.

E. Ensure that all appropriate markings are printed on the packages and labels are attached.

F. Make any appropriate advance arrangements with the carrier and obtain current information about regulations and specifications that might affect the shipment.

G. Prepare the cargo airbill, complete, and sign the appropriate declarations for transporting dangerous goods.

H. Deliver the shipment to the local office of the freight carrier or arrange for a pickup at the site. Do not seal the container until the freight carrier is satisfied that the internal packaging meets all applicable regulations.

I. Ensure that all chain-of-custody procedures are observed. Enclose the original chain of custody in the shipping package and return a copy for documentation purposes. Before enclosing the chain of custody form and sealing the package, have the courier of cargo agent receive custody of the package by signing the chain of custody.

3.4. Postoperation

3.4.1. Field

A. When transferring the samples, have the transferee sign and record the date and time on the Custody Transfer Record/Lab Work Request form (see SOP 1.3, Sample Control and Documentation). Custody transfers made to a sample custodian in the field should account for each sample, although samples may be transferred as a group. Every person who takes custody should fill in the appropriate section of the Custody Transfer Record/Lab Work Request form.

B. The field custodian is responsible for properly packaging and dispatching samples to the appropriate laboratory. This responsibility includes completing, dating, and signing the appropriate portion of the Custody Transfer Record/Lab Work Request form. When samples of hazardous materials are shipped to a laboratory, provide advance notice.

C. Verify that all sample bottles have been correctly identified and labels include necessary information (for example, location, time, and date). The minimum amount of information required on the sample bottle label is presented in SOP 1.3.

3.4.2. Documentation

A. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

B. As in any other activity that may be used to support litigation, regulatory agencies must be able to provide the chain of possession and custody of any samples that are offered for evidence or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever samples for evidence are collected, transferred, stored, analyzed, or destroyed. The primary objective of these procedures is to create an accurate, written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and the introduction as evidence.

A sample is in someone's custody under any of the conditions listed below.

- It is in one's actual possession.
- It is in one's view (after being in one's physical possession).
- It is one's physical possession and then locked up so that no one can tamper with it.
- It is kept in a secured area that is restricted to only authorized personnel.

C. A Custody Transfer Record/Lab Work Request form must accompany all packages sent to the laboratory. Retain a copy of these forms at the originating office (either carbon or photocopy). Register mailed packages with a return receipt requested. For packages sent by common carrier, retain receipts as part of the permanent chain-of-custody documentation. Pack samples to eliminate the possibility of breakage during shipment. Seal or lock the package so that any tampering can be readily detected.

D. Additional guidelines for chain of custody, a sample of the form, and instructions for completing the Custody Transfer Record/Lab Work Request form are included in SOP 1.3, Sample Control and Documentation.

3.4.3. <u>Office</u>

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

4. SOURCES

International Air Transport Association. 1988. Dangerous Goods Regulations. January 1988. Montreal, Quebec, Canada.

CFR 49. 1985. Code of Federal Regulations, Title 49, U.S. Department of Transporatation, Parts 100-199. November 1, 1985. Washington, D.C.: U.S. Government Printing Office.

5. APPENDICES

5.1 Environmental Samples

5.2 Samples of Hazardous Materials

5.3 Transportation of Unknown Hazardous Materials by 49 CFR

5.4 Transportation of Unknown Hazardous Materials by IATA

APPENDIX 5.1

ENVIRONMENTAL SAMPLES

A. Environmental Samples

Environmental samples may be packaged and shipped according to the following procedures.

B. Packaging

Environmental samples must be packaged according to the following procedures.

1. Place sample container, properly identified with a sealed lid, into a polyethylene bag and seal the bag.
2. Place sample in a fiberboard container approved by the Department of Transportation (DOT) or picnic cooler that has been lined with a large polyethylene bag.
3. Pack container with enough noncombustible, absorbent cushioning material to minimize the possibility of breakage and absorb any materials that may have leaked from the sample jars. Vermiculite is recommended.
4. If there are multiple samples, be sure there is sufficient cushioning material between the sample containers (each in its individual polyethylene bag) to prevent breakage from dropping or severe shock.
5. Seal large bag and add any needed absorbent.
6. Seal outside container with duct tape or strapping tape.

Before any samples are placed in their final shipping containers, the exterior of the sample containers should be wiped clean with a detergent solution.

C. Marking/Labeling

Sample containers must have a completed sample identification tag (see SOP 1.3, Sample Control and Documentation), and the outside container must be marked <u>Environmental Sample</u>. The appropriate side of the container must be marked <u>This End Up</u>, and arrow labels should be used accordingly. No DOT placards or labeling are required. Assure that all sample containers are labeled identically to labels on the shipping container.

APPENDIX 5.1, Concluded

ENVIRONMENTAL SAMPLES

D. Shipping Papers

No DOT or International Air Transport Association (IATA) shipping papers are required.

E. Transportation

There are no DOT or IATA restrictions on the mode of transportation. An overnight carrier is recommended.

APPENDIX 5.2

SAMPLES OF HAZARDOUS MATERIALS

A. Samples of Hazardous Material

Samples that are not environmental samples or samples known or expected to contain hazardous substances must be considered samples of hazardous material and transported according to the following requirements.

If the hazardous material in the sample is known or can be accurately identified, it is packaged, marked, labeled, and shipped according to the specific instructions for that material described in the Department of Transportation Hazardous Materials Table (49 CFR 172.101) or the latest edition of the International Air Transport Association Dangerous Goods Regulations.

APPENDIX 5.3

TRANSPORTATION OF UNKNOWN HAZARDOUS MATERIALS BY 49 CFR

A. Transportation of Unknown Hazardous Materials by 49 CFR

1. For samples of hazardous substances of unknown content that will be shipped by surface carrier under 49 CFR Transportation Regulations, the appropriate transportation category is selected through a process of elimination using the Department of Transportation (DOT) Hazardous Materials Classification system. While it is probable that most unknown samples of hazardous material shipped by field personnel will not contain radioactive materials or Poison A materials, it is essential for the following gradient hierarchy to be considered.

2. If radiation survey instruments demonstrate (or reasonable probability exists) that the unknown hazardous sample is radioactive, the appropriate DOT shipping regulations for radioactive material must be followed. Contact the subcontractor's health and safety officer for ER Program technical assistance for specific details.

3. If radioactive material is eliminated, the sample must then be considered to contain Poison A materials. DOT defines Poison A as an extremely dangerous, poisonous gas or a gas or liquid of the nature that a very small amount of gas (or vapor of the liquid) will be dangerous to life. Most Poison A materials are gases and would not be found in glass or drum-like containers. All samples taken from closed containers do not have to be shipped as Poison As. Based upon information available, judgment must be made as to whether a sample from a closed container is a Poison A. For specific instructions on the proper procedures for shipping Poison A, contact the subcontractor's health and safety officer for ER Program technical assistance.

4. If Poison A is eliminated as a shipment category, the next two classifications are flammable or nonflammable gases. Because an open container is not expected to contain a significant amount of gas, flammable liquid would be the next applicable category. After the categories of radioactive material, Poison A flammable gas, and nonflammable gas have been eliminated, the sample can be classified as a flammable liquid and shipped accordingly.

5. These procedures would also suffice for shipping any other samples classified below Poison A in the DOT classification table.

6. These procedures would also suffice for shipping any other samples classified below flammable liquids in the DOT classification table.

B. Shipment of Flammable Liquid By 49 CFR

The following instructions apply to the shipment of a flammable liquid by rail car, truck, or other common carrier.

1. Collect the sample in a glass or polyethylene container with a metallic, Teflon-lined screw cap. The container may be no larger than 16 fluid oz. To prevent leakage, fill the container no more than 90% full. Mark the fluid level on the outside of the sample container. If an air space in the sample container would affect sample integrity (for example, the case of a volatile organics analysis vial), place that container within a second container to meet the 90% requirement. Before any samples are placed in the final shipping container, the exterior should be decontaminated as specified in the Sampling Plan.

2. Complete the sample identification tag (see SOP 1.3, Sample Control and Documentation) and attach it securely to the sample container. The sample identification tag should contain information needed to trace the sample to its point of origin and sample taker, as well as any quality assurance/quality control information.

3. Seal the container and place it in a 2-ml-thick (or thicker) polyethylene bag with one sample in each bag. Position the identification tag so that it can be read through the bag. Seal the bag.

4. Place the sealed bag inside a metal can and cushion it with enough noncombustible, absorbent material (for example, vermiculite) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to secure the lid onto the can.

5. Place one or more metal cans into a strong outside container (like a picnic cooler or a DOT-approved fiberboard box). Surround cans with noncombustible, absorbent cushioning material for stability during transport. Total sample volume in the picnic cooler or fiberboard box should not exceed 10 gallons. A separate air bill and shipping declaration must be processed for each container or combination of containers so that the total sample volume on any air bill will not exceed 10 gallons.

C. Shipment by Land

The following instructions apply for shipment of samples of hazardous material by car or truck (not by common carrier).

1. The above instructions for flammable liquids will apply.

2. Additionally, sample containers must be firmly secured so that they will not bounce against the sides of the vehicle during transit or in an accident.

3. Limit shipments to 1000 lbs or less. Under 1000 lbs, there are no placarding requirements under 49 CFR 172.504 (c) (1).

D. Chain of Custody

Include the Custody Transfer Record/Lab Work Request form (properly executed) on the outside of the container. It is also recommended to use chain-of-custody tape over each can lid.

E. Marking and Labeling Samples Classified as Flammable Liquid

1. Use abbreviations only where specified.

2. Place the information listed below on each paint can.

    - Laboratory name and address

    - Flammable Liquid, N.O.S. UN 1993. The designation N.O.S. means not otherwise specified. Use an approved DOT label.

3. Information placed on cans should also be placed on at least one side of the outside shipping containers. If labelling is placed on more than one side, it must be attached to all visible sides.

4. "Cargo Aircraft Only" must be used on all outside shipping containers.

5. Print "Laboratory Samples" and "This End Up" or "This Side Up" clearly on top of the outside shipping container. Outside containers must also contain the statement "Inside packages comply with prescribed specifications". Put upward pointing arrows on all four sides of container.

F. Shipping Papers for Samples Classified as Flammable Liquid

Shipping papers must be provided for the shipment of all samples (including those transported by rental, government, company, or personal cars).

G. Bill of Lading/Certification Statement

Complete the bill of lading and sign the certification statement. If the carrier does not provide it, use a standard industry form. Provide the information listed below in the order listed. One form may be used for more than one outside container.

- Flammable Liquid, N.O.S. UN 1993

- Limited Quantity (or Ltd. Qty.)

- Net weight or net volume (weight or volume may be abbreviated) just before or after the UN or ID number.

- Further description like"Laboratory Samples" is allowed if it does not contradict required information.

H. Transportation

1. Transport samples of unknown hazardous material that are classified as flammable liquid by rented or common carrier truck or railroad, as appropriate.

2. Do not transport by any passenger carrying air transport system.

APPENDIX 5.4

TRANSPORTATION OF UNKNOWN HAZARDOUS MATERIAL BY IATA

A. Transportation of Unknown Hazardous Material by International Air Transport Association (IATA)

For samples containing unknown material that will be shipped by air carrier, the most appropriate classification in the IATA regulations is the classification of <u>other regulated substances.</u> In order to use this designation, the categories shown below must be eliminated.

- Radioactive Materials
- Poison A Materials
- Flammable Gases
- Nonflammable Gases

B. Shipment of Other Regulated Substances

The instructions below will apply for the shipment of other regulated substances by cargo-carrying aircraft, rail car, or other common carrier.

1. Collect the sample in a glass or polyethylene container with a nonmetallic, Teflon-lined screw cap. The container may be no larger than 16 fluid oz. To prevent leakage, fill the container no more than 90% full. If an air space in the sample container would affect sample integrity (for example, the case of a volatile organics analysis vial), place that container within a second container to meet the 90% requirement. Before any samples are placed in the final shipping container, the exterior should be wiped clean with detergent solution.

2. Complete the sample identification tag (see SOP 1.3, Sample Control and Documentation) and attach it securely to the sample container. The sample identification tag should contain information needed to trace the sample to its point of origin and sample taker, as well as any quality assurance/quality control information.

3. Seal the container and place it in a 2-ml-thick (or thicker) ..yethylene bag with one sample in each bag. Position the identification tag so that it can be read through the bag. Seal the bag.

4. Place the sealed bag inside a metal can and cushion it with enough noncombustible, absorbent material (for example, vermiculite) between the bottom and sides of the can and bag to prevent breakage and absorb leakage. Pack one bag per can. Use clips, tape, or other positive means to secure the lid onto the can.

5. Place one or more metal cans into a strong outside container (like a picnic cooler or a DOT-approved fiberboard box). Surround cans with noncombustible, absorbent cushioning material for stability during transport. Total sample volume in the picnic cooler or fiberboard box should not exceed 40 liters.

C. Chain of Custody

Include the Custody Transfer Record/Lab Work Request form (properly executed) in the outside container. It is also recommended to use chain-of-custody tape over each can lid.

D. Marking and Labeling Samples Classified as Other Regulated Substances

1. Use abbreviations only where specified.

2. Place the information listed below on each paint can.

   - Laboratory name and address

   - Other regulated substances, UN8027. Hazardous Class # 9

3. Information placed on cans should also be placed on at least one side of the outside shipping containers. If labelling is placed on more than one side, it must be attached to all visible sides.

4. Cargo Aircraft Only must be printed on all outside shipping containers.

5. Print Laboratory Samples and This End Up or This Side Up clearly on top of the outside shipping container. Outside containers also must contain the statement Inside Packages to Comply with Prescribed Specifications. Put upward pointing arrows on all four sides of the container.

E. Shipping Papers for Samples Classified as Other Regulated Substances

Shipping papers must be provided for the shipment of all samples (including those transported by rental, government, company, or personal cars).

F. Bill of Lading/Certification Statement

Complete the bill of lading and sign the certification statement. If the carrier does not provide it, use a standard industry form. Provide the information listed below in the order listed. One form may be used for more than one outside container.

- Other Regulated substances, UN8027

- Class or Division #9

- Net weight or net volume (weight or volume may be abbreviated) just before or after the UN or ID number.

- Further description (like Laboratory Samples) is allowed if it does not contradict required information.

G. Transportation

1. Transport samples of unknown hazardous material that are classified as other regulated substances by rented or common carrier truck, railroad, express overnight package services, or other appropriate means.

2. Do not transport by any passenger-carrying air transport system. Ship by air carriers that transport only cargo (for example, Federal Express).

STANDARD OPERATING PROCEDURE 1.6

GENERAL EQUIPMENT DECONTAMINATION

1. PURPOSE

To describe methods for the decontamination of field equipment potentially contaminated during sample collection.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information about the scope and details of a given operation. The RIP also contains specifications for the use of decontamination agents, areas where decontamination will be performed, and quality assurance procedures to verify the effectiveness of the decontamination procedures. Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross-contamination among samples and helps maintain a clean working environment for the safety of all field personnel.

Decontamination is mainly achieved by rinsing with liquids that include soap or detergent solutions, tap water, deionized water, and methanol. Equipment is allowed to air dry after being cleaned or wiped dry with chemical-free cloths or paper towels. It can then be reused immediately. Steam cleaning should be used whenever visible contamination exists or for large machinery/vehicles.

It is the primary responsibility of the site manager to assure that proper decontamination procedures are followed and that all waste materials produced are properly stored or disposed of. It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and ensure that contaminants are not negligently introduced into the environment.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.7	Sampling for Removable Alpha Contamination

SOP No.	SOP Title
6.4	Total Alpha Surface Contamination Measurements
6.11	Beta-Gamma Radiation Measurements Using a Geiger-Mueller Detector

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1.

E. Notify the analytical laboratory of the decontamination blank sample and the approximate arrival date.

F. Contact the carrier that will transport the sample to obtain information on regulations and specifications.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. There are no forms required to document decontamination procedures and the degree of decontamination attained.

3.2.3. Field

A. Assemble containers and equipment for decontamination.

B. Decontaminate all equipment before use.

3.3. Operation

The extent of known contamination determines the extent to which equipment must be decontaminated. If the extent of contamination cannot be readily determined, clean the equipment on the assumption that it is highly contaminated until enough data are available to allow an accurate assessment of the level of contamination.

Adequate supplies of rinsing liquids and all materials should be available. Perform decontamination in the same level of protective clothing as sampling activities unless a different level of protection is specified in the RIP Health and Safety Plan.

The procedure for full field decontamination follows. Any deviations from this procedure for a specific project are included in the RIP.

Decontamination Steps

1. The purpose of the initial step is to remove gross contamination. Remove any solid particles from the equipment or material by brushing and then rinsing with available tap water. For drilling equipment, steam cleaning is necessary.

2. Wash equipment with soap or detergent solution.

3. Rinse with tap water by submerging or spraying.

4. For organic contaminants, an <u>optional</u> rinse with a solvent (methanol or acetone) may be completed to dissolve and remove contaminants.

5. Rinse thoroughly with distilled water.

6. Air dry equipment or rinse with nanograde (i.e. low residue) methanol to expedite drying (optional).

7. If radiation screening is required by the RIP, screen the equipment with a radiation detector according to SOP 1.7, Sampling for Removable Alpha Contamination; SOP 6.4, Total Alpha Surface Contamination Measurements; or SOP 6.12, Radon-222 Flux Measurements Using Charcoal Canisters. If activity above the limits for unrestricted use is detected, repeat steps 1-6.

8. Samples of drippings from the last rinse in step 5 may be collected and analyzed to verify the effectiveness of the decontamination procedure. This type of sample is called a decontamination blank. The results of these analyses are not usually available for at least one week after they arrive in the laboratory, so it is important to do a thorough decontamination from the start of the sampling activity to minimize the potential for a positive <u>hit</u> in the decontamination drippings.

9. Upon termination of a borehole, decontaminate all drilling, packer testing, and geophysical logging equipment as well as well casing and screen.

10. Drilling decontamination will include:

    1. A rinse with the steam cleaner using organic-free water.

    2. Scrubbing with brushes using a solution of organic-free water and an alkaline detergent.

    3. A final rinse with the steam cleaner using organic-free water.

11. Cover drilling equipment with a clean sheet of plastic after it is decontaminated. Install wet casing and screen in the borehole.

12. Decontaminate all equipment and tools used in well installation.

13. Before moving to the next drill site, decontaminate the wire-line cable by pulling it off the drum to the appropriate length. Also decontaminate the rig table and mat.

3.4. Postoperation

3.4.1. Field

A. Decontaminate as much sampling equipment as possible and properly dispose of expendable items that cannot be decontaminated. Proper disposal may involve onsite drumming of liquids and solids in approved containers for subsequent disposal. Expensive items like machinery may require a more advanced decontamination analysis.

B. Prepare the decontamination blank sample and transport it according to SOP 1.3, Sample Control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

C. Store containers of solutions produced during decontamination in a secure area.

D. Dispose of any soiled materials as designated in the RIP.

3.4.2. Documentation

A. Record radiological measurements in the logbook before leaving the site.

B. There are no forms required to document decontamination procedures and the degree of contamination attained.

3.4.3. Office

A. Deliver original logbooks to the site manager for technical review. He/she will review and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that the sample arrives safely and instructions for analyses are clearly understood.

D. After receiving the results of the laboratory analyses, arrange for the disposal of wastes generated during the investigation.

4. SOURCE

NIOSH, OSHA, USCG and EPA. 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities." prepared by the National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Coast Guard (USCG), and the U.S. Environmental Protection Agency (EPA). U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH report, October 1985. Washington, D.C.: U.S. Government Printing Office.

5. APPENDIX

5.1. Equipment and Supplies Checklist

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

________ Decontamination solutions preselected by the laboratory

________ Cleaning liquids: soap or detergent solutions, tap water, deionized water, and methanol

________ Chemical-free paper towels

________ Cleaning brushes

________ Cleaning containers: plastic buckets and galvanized steel pans

________ Waste storage containers: drums and plastic bags

STANDARD OPERATING PROCEDURE 1.8

PERSONNEL DECONTAMINATION--LEVEL D PROTECTION

1. PURPOSE

To describe the equipment and procedures required for the decontamination of persons who have performed field activities in Level D protective clothing.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information about the scope and details of a specific operation. Refer to the RIP Health and Safety Plan for recommendations about the level of protection worn to enter a site and the criteria for upgrading to higher levels of protection.

Level D protective clothing is primarily a work uniform. This level of protection is worn when work functions preclude splashes, immersion, inhalation, or exposure to materials above the action limits specified in the RIP.

Although Level D protection is worn under these conditions, workers may be wearing disposable coveralls and gloves, safety boots/shoes, a hard hat, and safety glasses. Therefore, the site Health and Safety Plan must address the proper disposition of disposable clothing and decontamination measures that should be implemented. The disposition of disposable items must follow installation requirements and any applicable state and federal regulations.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information on equipment and supplies; sample collection, preservation, packaging, and shipping; documentation procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
1.9	Personnel Decontamination--Level C Protection
1.10	Personnel Decontamination--Level B Protection

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. The RIP Health and Safety Plan will specify the procedures and equipment required for the decontamination and disposal of Level D protective clothing. All onsite personnel will be informed about the proper disposal of protective clothing and any decontamination solutions used.

C. Appendix 5.1 lists the items suggested for Level D decontamination. This list provides general guidelines and can be modified in order to meet site-specific work activities or features.

D. Obtain necessary clothing, protective gear, and equipment. Read the Health and Safety Plan and ensure that necessary decontamination materials are available.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. There are no forms required to document decontamination procedures and the degree of decontamination attained.

3.2.3. Field

Before initiating field activities, designate an area for decontamination activities. Although Level D areas should be minimally contaminated, always use caution to prevent the potential spread of any unknown contaminants.

3.3. Operation

The following decontamination procedures are recommended for Level D protection. These measures represent suggested guidelines and may be modified to meet site-specific conditions.

A. Remove any disposable coveralls, rubber gloves, and boot covers and place in a plastic trash sack.

B. If dusty conditions have been encountered, use water-dampened paper towels to remove the dust from hard hats and safety glasses/goggles. Place used paper towels in a trash sack.

C. If necessary, decontaminate safety boots with water and a steel brush. Do not wear muddy or dusty boots out of the exclusion zone.

D. All workers should wash hands and face before leaving the site.

E. All workers should change clothing and shower as soon as possible after the day's work activities.

3.4. Postoperation

3.4.1. Field

Collect all trash sacks containing disposable clothing. Dispose of trash sacks according to the requirements of the site Health and Safety Plan. The site manager or field team leader is responsible for the safe disposal of any items.

3.4.2. Documentation

A. Record radiological measurements in the logbook before leaving the site.

B. There are no forms required to document decontamination procedures and the degree of decontamination attained.

3.4.3. Office

Return all unused items to the equipment manager. The equipment manager should be informed of all stock items that need to be ordered to replenish the inventory.

4. SOURCES

NIOSH, OSHA, USCG and EPA. 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities." Prepared by the National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Coast Guard (USCG) and the U.S. Environmental Protection Agency (EPA). U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH report, October 1985. Washington, D.C.: U.S. Government Printing Office.

EPA. 1984. "Standard Operating Safety Guides." Environmental Response Branch, Hazardous Response Support Division, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, November 1984. Washington, D.C.: U.S. Government Printing Office.

5. APPENDIX

5.1. Equipment and Supplies Checklist

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

________ Plastic trash sacks
  30-gallon size: (no. of boxes) ________
  20-gallon size: (no. of boxes) ________

________ Plastic wash tub: (number) ________

________ Paper towels: (no. of rolls)________

________ Liquid hand soap

________ Wet wipe towelettes

________ Water container
(size) 1 gallon________ 5 gallon________

________ Brushes (scrub or wire)

________ Alpha scintillation detector

STANDARD OPERATING PROCEDURE 1.9

PERSONNEL DECONTAMINATION--LEVEL C PROTECTION

1. PURPOSE

To describe the equipment and procedures required for the decontamination of persons who have performed field activities in Level C protection clothing.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information regarding the scope and details of a specific operation. Refer to the RIP Health and Safety Plan for recommendations about the level of protection worn to enter a site and the criteria for upgrading or downgrading to other levels of protection.

Protective clothing and equipment must be worn by personnel when known or suspected hazardous substances are involved. The necessary equipment and procedures for decontaminating personnel in Level C protection are addressed in this SOP. The procedures include maximum and minimum decontamination measures.

The establishment of decontamination lines is site specific; these lines depend upon the types of contamination and the work performed. When the decontamination line is no longer required, contaminated wash and rinse solutions and articles must be contained and disposed of appropriately. Disposal must follow installation requirements and any applicable state and federal regulations.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information on equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
1.8	Personnel Decontamination--Level D Protection
1.10	Personnel Decontamination--Level B Protection

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. The selection of the appropriate level of personnel decontamination is site specific and is given in the site Health and Safety Plan. Coordinate any changes with the site health and safety coordinator. Considerations for selection include work activity, known or suspected contaminants, previous experience at the site, and health and safety requirements.

C. The site Health and Safety Plan should include details of the procedures for the ultimate disposal of protective clothing and waste water. The packaging and disposal procedures must be approved by the installation authorities responsible for waste disposal. Inform all onsite personnel about the proper disposal of protective clothing and decontamination solutions.

D. Appendix 5.1 includes recommendations for equipment and supplies used in maximum decontamination measures. Appendix 5.2 includes recommendations for equipment and supplies used in minimum decontamination measures. These appendixes contain general equipment guidelines. The selection of equipment must be site specific to incorporate unusual work activities or site features. Detailed information is in the RIP.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. There are no forms required to document decontamination procedures and the degree of decontamination attained.

3.2.3. Field

A. Before field activities begin, establish site work zones to prevent the accidental spread of hazardous substances. The establishment of work zones is site specific and coordinated with the site health and safety coordinator at the time the Health and Safety Plan is prepared. Considerations for establishing work zones should include wind direction, weather conditions, emergency situations, changes in site activities, and access.

B. Appendix 5.3 shows an example of a maximum decontamination layout for Level C protection. Appendix 5.4 shows an example of the minimum decontamination layout for Level C protection.

NOTE: The layouts may be modified according to site-specific conditions.

3.3. Operation

3.3.1. Maximum Decontamination Measures

The maximum decontamination measures for Level C are described in Appendix 5.5. These measures are guidelines and may be modified according to site-specific conditions.

3.3.2. Modification of Maximum Decontamination Measures

Depending upon site-specific conditions and circumstances, modifications to the maximum decontamination measures may be permissible. Two example situations in which the maximum decontamination measures may be modified are described below.

A. Situation 1--The individual entering the contamination reduction zone is expected to be minimally contaminated. Extremely skin-corrosive materials are not present. Outer gloves and boot covers are worn. The inner gloves and safety boots are not contaminated.

The following decontamination stations described in Appendix 5.5 would be utilized in this situation: Station Numbers 1, 4-8, 10-11, and 14-17.

B. Situation 2--The individual entering the contamination reduction zone is expected to be minimally contaminated. Extremely toxic or skin-corrosive materials are not present. Outer gloves and boot covers are worn. The inner gloves and safety boots are not contaminated. The individual needs a new canister or mask and will return to the exclusion zone.

The following decontamination stations described in Appendix 5.5 would be utilized in this situation: Station Numbers 1 and 4-9.

3.3.3. Minimum Decontamination Measures

The minimum decontamination measures for Level C are described in Appendix 5.6. These measures are guidelines and may be modified according to site-specific conditions.

3.4. Postoperation

3.4.1. Field

After the completion of field activities, all contaminated wash and rinse waters, decontamination solutions, and contaminated articles must be properly disposed of. The disposal methods must follow installation requirements. The site manager or field team leader is responsible for the safe disposal of contaminated materials. Planning for the proper disposal should be included during office preparation before field activities begin.

3.4.2. Documentation

A. Record all monitoring instrument measurements in the logbook before leaving the site.

B. There are no forms required to document decontamination procedures and the degree of decontamination attained.

3.4.3. Office

Return all unused or properly decontaminated equipment will be returned to the equipment manager. The equipment manager should be informed of all stock items that need to be ordered to replenish the inventory.

4. SOURCES

NIOSH, OSHA, USCG and EPA. 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities." Prepared by the National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Coast Guard (USCG), and the U.S. Environmental Protection Agency (EPA). U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH report, October 1985. Washington, D.C.: U.S. Government Printing Office.

EPA. 1984. "Standard Operating Safety Guides." Environmental Response Branch, Hazardous Response Support Division, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency document, November 1984. Washington, D.C.: U.S. Government Printing Office.

5. APPENDICES

5.1. Equipment and Supplies for Maximum Decontamination Measures for Level C

5.2. Equipment and Supplies for Minimum Decontamination Measure for Level C

5.3. Maximum Decontamination Layout for Level C Protection

5.4. Minimum Decontamination Layout for Level C Protection

5.5. Maximum Measures for Level C Decontamination

5.6. Minimum Measures for Level C Decontamination

APPENDIX 5.1

EQUIPMENT AND SUPPLIES FOR MAXIMUM DECONTAMINATION MEASURES FOR LEVEL C

Station 1:
a. Various Size Containers
b. Plastic Liners
c. Plastic Drop Cloths

Station 2:
a. Containers (20-30 Gallons)
b. Decon Solution or Detergent Water
c. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 3:
a. Containers (20-30 Gallons)
or
High-pressure Spray Unit
b. Water
c. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 4:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 5:
a. Containers (20-30 Gallons)
b. Plastic Liners
c. Bench or Stools

Station 6:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 7:
a. Containers (20-30 Gallons)
b. Decon Solution or Detergent Water
c. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 8:
a. Containers (20-30 Gallons)
or
High-pressure spray Unit
b. Water
c. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 9:
a. Air Tanks or Face Masks and Cartridge, Depending on Level
b. Tape
c. Boot Covers
d. Gloves

Station 10:
a. Containers (20-30 Gallons)
b. Plastic Liners
c. Bench or Stools
d. Boot Jack

Station 11:
a. Rack
b. Drop Cloths
c. Bench or Stools

Station 12:
a. Table

Station 13:
a. Basin or Bucket
b. Decon Solution
c. Small Table

Station 14:
a. Water
b. Basin or Bucket
c. Small Table

Station 15:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 16:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 17:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 18:
a. Water
b. Soap
c. Small Table
d. Basin or Bucket
e. Field Showers
f. Towels

Station 19:
a. Dressing Trailer in Inclement Weather
b. Tables
c. Chairs
d. Lockers
e. Cloths

Sources: NIOSH, OSHA, USCG and EPA, October 1985.
U.S. EPA, November 1984.

APPENDIX 5.2

EQUIPMENT AND SUPPLIES FOR MINIMUM DECONTAMINATION MEASURES FOR LEVEL C

Station 1:
- a: Various Size Containers
- b. Plastic Liners
- c. Plastic Drop Cloths

Station 2:
- a. Containers (20-30 Gallons)
- b. Decon Solution
- c. Rinse Water
- d. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 3:
- a. Containers (20-30 Gallons)
- b. Plastic Liners
- c. Bench or Stools

Station 4:
- a. Air Tanks or Masks and Cartridges, Depending Upon
- b. Tape
- c. Boot Covers
- d. Gloves

Station 5:
- a. Containers (20-30 Gallons)
- b. Plastic Liners
- c. Bench or Stools

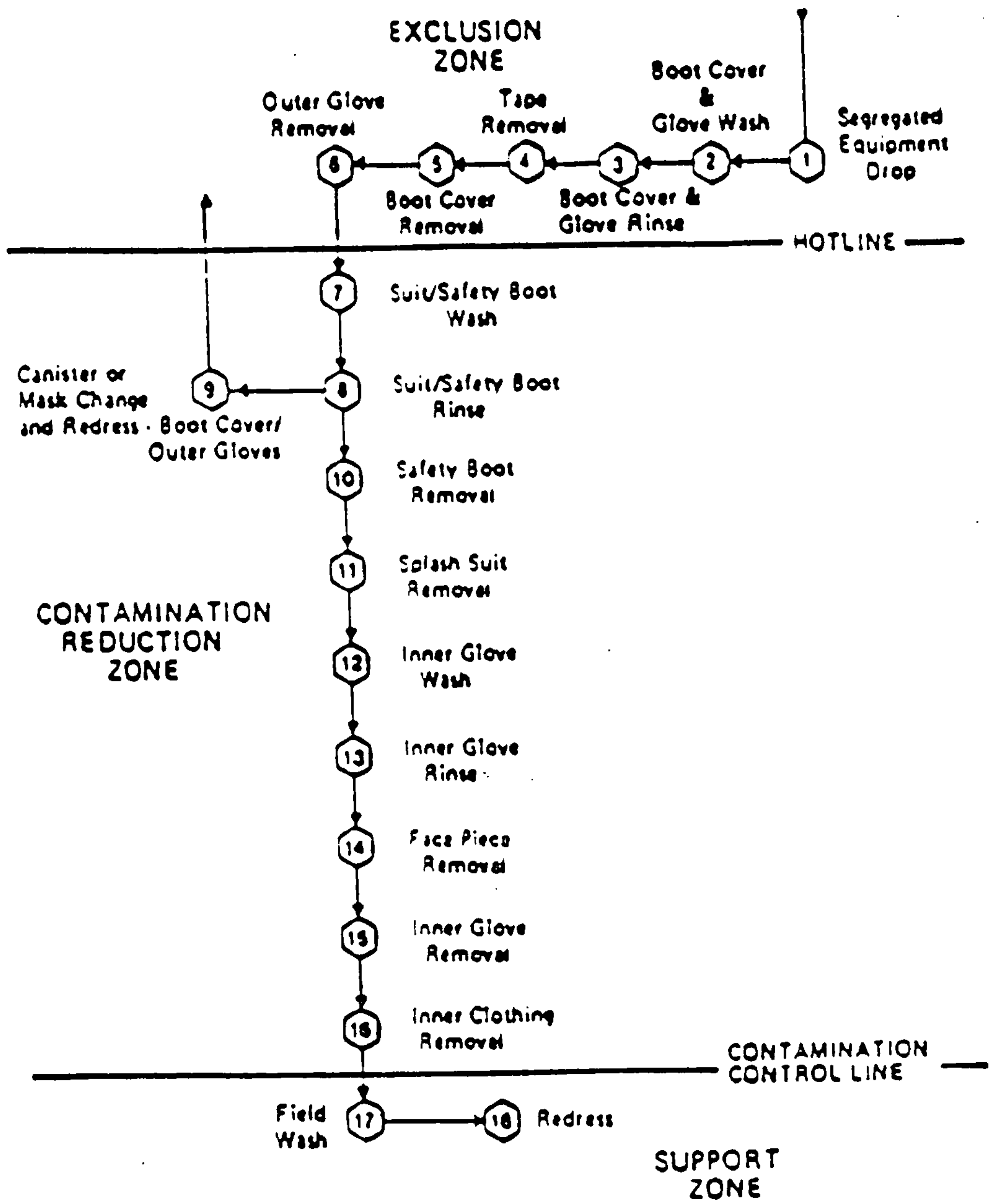
Station 6:
- a. Plastic Sheets
- b. Basin or Bucket
- c. Soap and Towels
- d. Bench or Stools

Station 7:
- a. Water
- b. Soap
- c. Tables
- d. Wash Basin or Bucket

Sources: NIOSH, OSHA, USCG and EPA, October 1985.
U.S. EPA, November 1984.

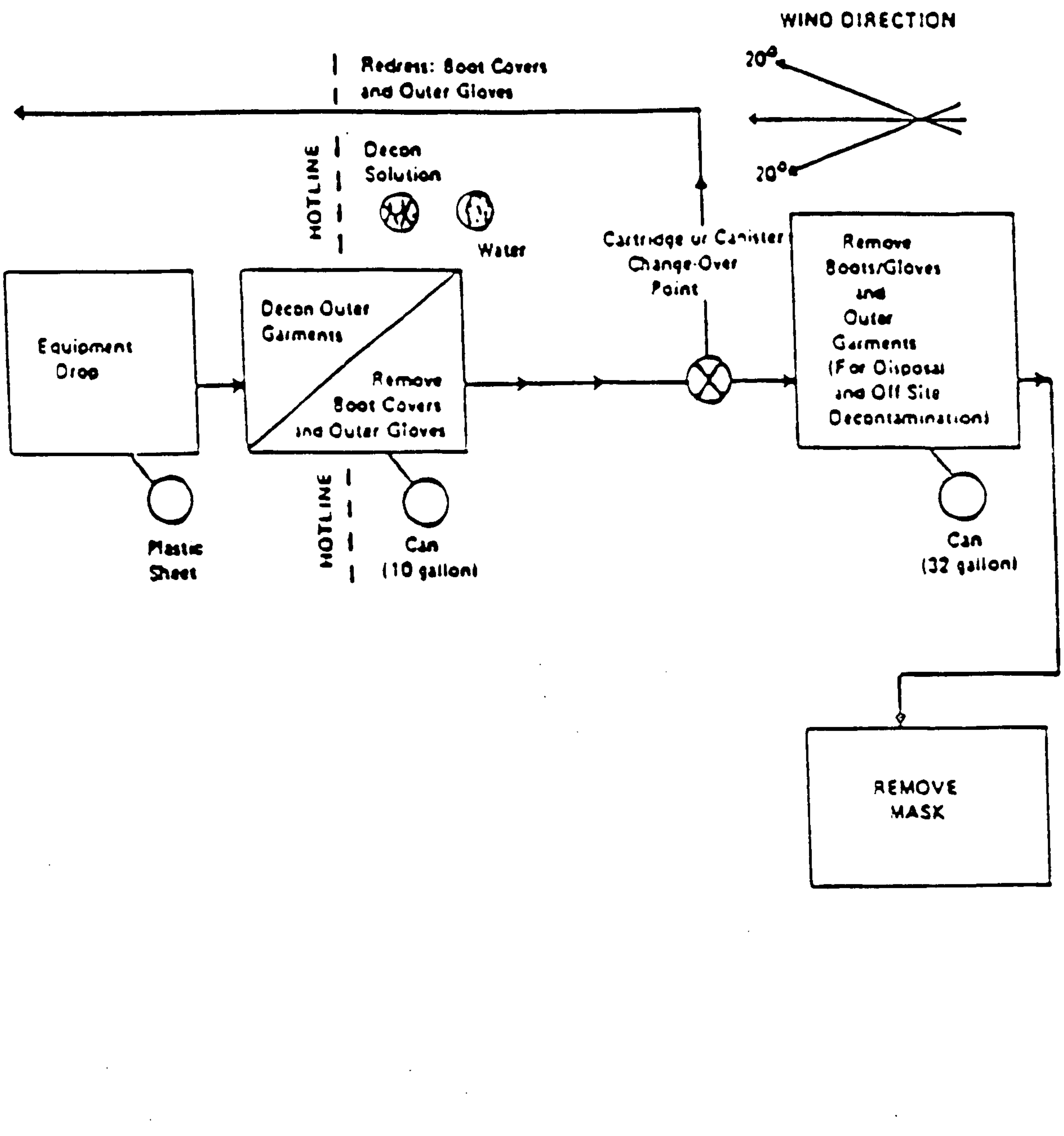
APPENDIX 5.3

MAXIMUM DECONTAMINATION LAYOUT FOR LEVEL C PROTECTION



APPENDIX 5.4

MINIMUM DECONTAMINATION LAYOUT FOR LEVEL C PROTECTION



APPENDIX 5.5

MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

Station 1:	Segregated Equipment Drop	1. Deposit equipment used at the site (tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	2. Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3. Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4. Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5. Remove boot covers and deposit in containers with plastic liner.
Station 6:	Outer Glove Removal	6. Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Boot Wash	7. Wash splash suit, gloves, and safety boots. Scrub with long-handled scrub brush and decon solution.
Station 8:	Suit and Boot and Glove Rinse	8. Rinse off decon solution using water. Repeat as many times as necessary.
Station 9:	Canister or Mask Change	9. If worker leaves exclusion zone to change canister (or mask), this is the last step in the decontamination procedure. The worker's canister is exchanged. New outer gloves and boot covers are put on, and joints are taped. The worker returns to duty.

APPENDIX 5.5, Concluded

MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

Station 10:	Safety Boot Removal	10. Remove safety boots and deposit in container with plastic liner.
Station 11:	Splash Suit Removal	11. With assistance of helper, remove splash suit. Deposit in container with plastic liner.
Station 12:	Inner Glove Rinse	12. Wash inner gloves with decon solution.
Station 13:	Inner Glove Wash	13. Rinse inner gloves with water.
Station 14:	Face Piece Removal	14. Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 15:	Inner Glove Removal	15. Remove inner gloves and deposit in lined container.
Station 16:	Inner Clothing Removal	16. Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing away from the site, because there is a possibility that small amounts of contaminants might have been transferred in removing the outer clothing. When applicable, begin a gross alpha contamination survey.
Station 17:	Field Wash	17. Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 18:	Redress	18. Put on clean clothes.

Sources: NIOSH, OSHA, USCG and EPA, October 1985.
U.S. EPA, November 1984.

APPENDIX 5.6

MAXIMUM MEASURES FOR LEVEL C DECONTAMINATION

Station 1:	Equipment Drop	1. Deposit equipment used at the site (tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2. Scrub outer boots, outer gloves, and splash suit with decon solution or detergent water. Rinse off using water.
Station 3:	Outer Boot and Glove Removal	3. Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Canister or Mask Change	4. If worker leaves exclusive zone to change canister (or mask), this is the last step in the decontamination procedure. The worker's canister is exchanged. New outer gloves and boot covers are put on, and joints are taped. The worker returns to duty.
Station 5:	Boots, Gloves, and Outer Garment Removal	5. Boots, chemical-resistant splash suit, and inner gloves are removed and deposited in separate containers lined with plastic.
Station 6:	Face Piece Removal	6. Face piece is removed. Avoid touching face with fingers. Face piece deposited on plastic sheet.
Station 7:	Field Wash	7. Hands and face are thoroughly washed. Shower as soon as possible.

Sources: NIOSH, OSHA, USCG and EPA, October 1985.
U.S. EPA, November 1984.

STANDARD OPERATING PROCEDURE 1.10

PERSONNEL DECONTAMINATION--LEVEL B PROTECTION

1. PURPOSE

To describe the equipment and procedures required for decontamination of persons who have performed field activities in Level B protection clothing.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information about the scope and details of a specific operation. Refer to the RIP Health and Safety Plan for recommendations about the level of protection worn to enter a site and the criteria for upgrading or downgrading to other levels of protection.

Protective clothing and equipment must be worn by personnel when known or suspected hazardous substances are involved. The necessary equipment and procedures for decontaminating personnel in Level B protection are addressed in this SOP. The procedures include maximum and minimum decontamination measures.

The establishment of decontamination lines is site specific. These lines depend upon the types of contamination and the work performed. When the decontamination line is no longer required, contaminated wash and rinse solutions and articles must be contained and disposed of appropriately. Disposal must follow installation requirements and any applicable state and federal regulations.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information on equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Other procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
1.8	Personnel Decontamination--Level D Protection
1.9	Personnel Decontamination--Level C Protection

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. The selection of the appropriate level of personnel decontamination is site specific and determined by the site health and safety coordinator. Consult the site Health and Safety Plan for the level of protection. Considerations for selection include work activity, known or suspected contaminants, previous experience at the site, and the installation of health and safety requirements specified by the facility's management company.

C. The site Health and Safety Plan should include details of the plans for ultimate disposal of protective clothing, waste water, and potentially contaminated articles. The packaging and disposal procedures must be approved by the installation authorities responsible for waste disposal. Inform all onsite personnel about the proper disposal of protective clothing and decontamination solutions.

D. Appendix 5.1 includes recommendations for equipment and supplies used in maximum decontamination measures. Appendix 5.2 includes recommendations for equipment and supplies used in minimum decontamination measures. These appendixes contain general equipment guidelines. The selection of equipment must be site specific to incorporate unusual work activities or site features. Detailed information is in the RIP.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. There are no forms required to document decontamination procedures and the degree of documentation attained.

3.2.3. Field

A. Before field activities begin, establish site work zones to reduce the accidental spread of hazardous substances. The establishment of work zones is site specific and coordinated with the site health and safety coordinator at the time the site Health and Safety Plan is prepared. Considerations for establishing work zones should include wind direction, weather conditions, emergency situations, changes in site activities, and access.

B. Appendix 5.3 shows an example of a maximum decontamination layout for Level B protection. Appendix 5.4 shows an example of the minimal decontamination layout for Level B protection.

NOTE: These layouts may be modified according to site-specific conditions.

3.3. Operation

3.3.1. Maximum Decontamination Measures

The maximum decontamination measures for Level B are described in Appendix 5.5. These measures are guidelines and may be modified according to site-specific conditions.

3.3.2. Modification of Maximum Decontamination Measures

Depending upon site-specific conditions and circumstances, modifications to the maximum decontamination measures may be permissible. Two example situations in which the maximum decontamination measures may be modified are described below.

A. Situation 1--The individual entering the contamination reduction zone is expected to be minimally contaminated. Extremely toxic or skin-corrosive materials are not present. Outer gloves and boot covers are worn. The inner gloves and boots are not contaminated.

   The following decontamination stations described in Appendix 5.5 would be utilized in this situation: Station Numbers 1, 4-8, 10-12, and 15-19.

B. Situation 2--The individual entering the contamination reduction zone is expected to be minimally contaminated. Extremely toxic or skin-corrosive materials are not present. Outer gloves and boot covers are worn. The inner gloves and boots are not contaminated. The individual needs a new air tank and will return to the exclusion zone.

   The following decontamination stations described in Appendix 5.5 would be utilized in this situation: Station Numbers 1, and 4-9.

3.3.3. Minimum Decontamination Measures

The minimum decontamination measures for Level B are described in Appendix 5.6. These measures are only guidelines and may be modified according to site-specific conditions.

3.4. Postoperation

3.4.1. Field

At the completion of field activities, all contaminated wash and rinse water, decontamination solutions, and contaminated articles must be properly disposed of. The disposal must follow installation requirements and any applicable state and federal regulations. The site manager or field team leader is responsible for the safe disposal of contaminated materials. Planning for proper disposal should be included during office preparations before field activities begin.

3.4.2. Documentation

A. Record all monitoring instrument measurements in the logbook before leaving the site.

B. There are no forms required to document decontamination procedures and the degree of decontamination attained.

3.4.3. Office

All unused or properly decontaminated equipment will be returned to the equipment manager. The equipment manager should be informed of all stock items that need to be ordered to replenish the inventory.

4. SOURCES

NIOSH, OSHA, USCG and EPA. 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities." Prepared by the National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), U.S. Coast Guard (USCG), and the U.S. Environmental Protection Agency (EPA). U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, NIOSH report, October 1985. Washington, D.C.: U.S. Government Printing Office.

EPA. 1984. "Standard Operating Safety Guides", Environmental Response Branch, Hazardous Response Support Division, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency document, November 1984. Washington, D.C.: U.S. Government Printing Office.

5. APPENDICES

5.1. Equipment and Supplies for Maximum Decontamination Measures for Level B

5.2. Equipment and Supplies for Minimum Decontamination Measures for Level B

5.3. Maximum Decontamination Layout for Level B Protection

5.4. Minimum Decontamination Layout for Level B Protection

5.5. Maximum Measures for Level B Decontamination

5.6. Minimum Measures for Level B Decontamination

APPENDIX 5.1

EQUIPMENT AND SUPPLIES FOR MAXIMUM DECONTAMINATION MEASURES FOR LEVEL B

Station 1:
a. Various Size Containers
b. Plastic Liners
c. Plastic Drop Cloths

Station 2:
a. Containers (20-30 Gallons)
b. Decon Solution or Detergent Water
c. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 3:
a. Containers (20-30 Gallons)
or
High-pressure Spray Unit
b. Water
c. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 4:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 5:
a. Containers (20-30 Gallons)
b. Plastic Liners
c. Bench or Stools

Station 6:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 7:
a. Containers (20-30 Gallons)
b. Decon Solution or Detergent Water
c. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 8:
a. Containers (20-30 Gallons)
or
High-pressure Spray Unit
b. Water
c. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 9:
a. Air Tanks
b. Tape
c. Boot Covers
d. Gloves

Station 10:
a. Containers (20-30 Gallons)
b. Plastic Liners
c. Bench or Stools
d. Boot Jack

Station 11:
a. Rack
b. Drop Cloths
c. Bench or Stools

Station 12:
a. Table

Station 13:
a. Basin or Bucket
b. Decon Solution
c. Small Table

Station 14:
a. Water
b. Basin or Bucket
c. Small Table

Station 15:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 16:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 17:
a. Containers (20-30 Gallons)
b. Plastic Liners

Station 18:
a. Water
b. Soap
c. Small Table
d. Basin or Bucket
e. Field Showers
f. Towels

Station 19:
a. Dressing Trailer Needed in Inclement Weather
b. Tables
c. Chairs
d. Lockers
e. Cloths

Sources: NIOSH, OSHA, USCG and EPA, October 1985.
U.S. EPA, November 1984.

APPENDIX 5.2

EQUIPMENT AND SUPPLIES FOR MINIMUM DECONTAMINATION MEASURES FOR LEVEL B

Station 1:
- a. Various Size Containers
- b. Plastic Liners
- c. Plastic Drop Cloths

Station 2:
- a. Containers (20-30 Gallons)
- b. Decon Solution
- c. Rinse Water
- d. 2-3 Long-handled, Soft-bristled Scrub Brushes

Station 3:
- a. Containers (20-30 Gallons)
- b. Plastic Lines
- c. Bench or Stools

Station 4:
- a. Air Tanks or Masks and Cartridges, Depending Upon the Concentration and Types of Airborne Contamination
- b. Tape
- c. Boot Covers
- d. Gloves

Station 5:
- a. Containers
- b. Plastic Liners
- c. Bench or Stools

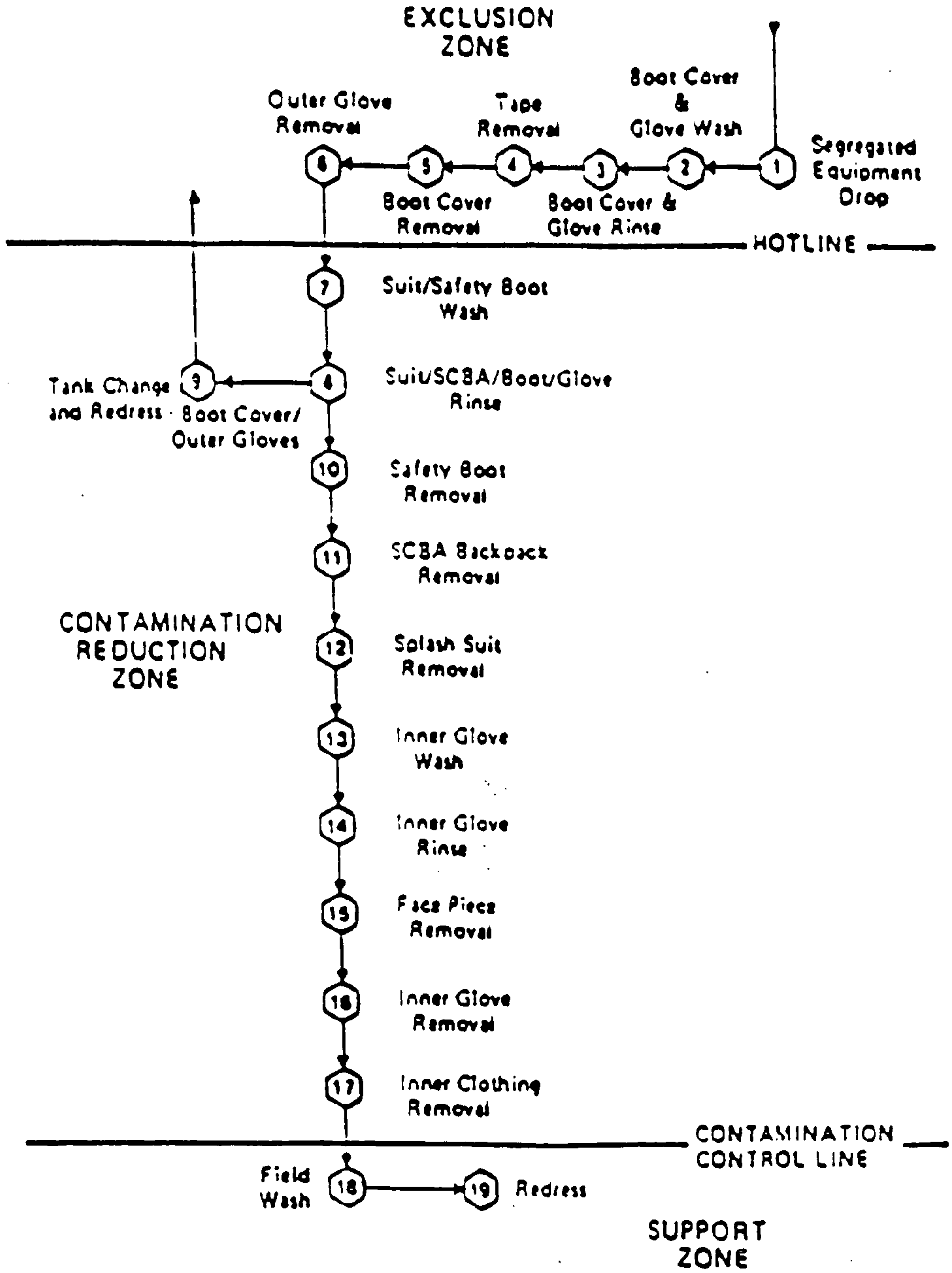
Station 6:
- a. Plastic Sheets
- b. Basin or Bucket
- c. Soap and Towels
- d. Bench or Stools

Station 7:
- a. Water
- b. Soap
- c. Tables
- d. Wash Basin or Bucket

Sources: NIOSH, OSHA, USCG and EPA, October 1985.
U.S. EPA, November 1984.

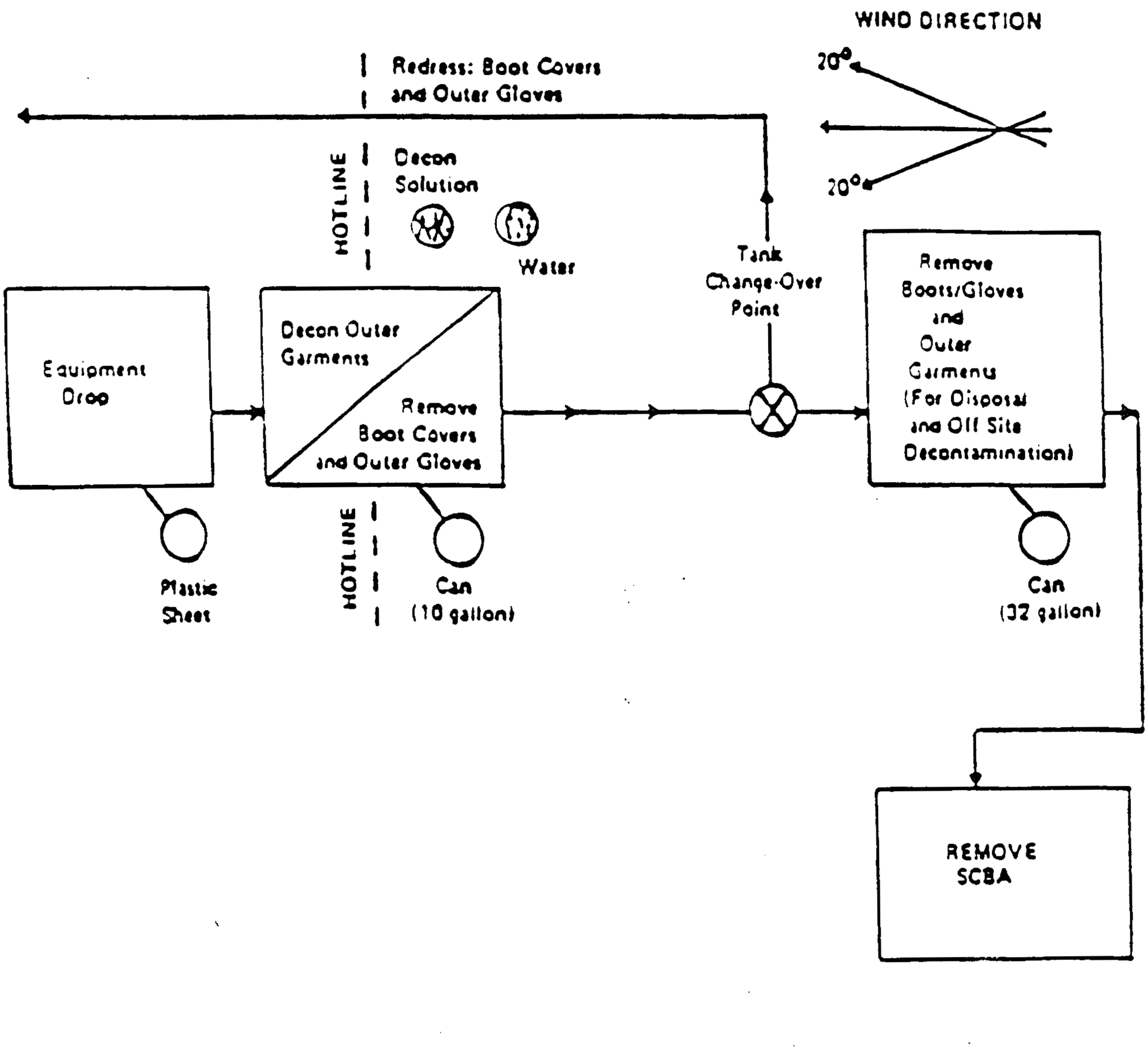
APPENDIX 5.3

MAXIMUM DECONTAMINATION LAYOUT FOR LEVEL B PROTECTION



APPENDIX 5.4

MINIMUM DECONTAMINATION LAYOUT FOR LEVEL B PROTECTION



APPENDIX 5.5

MAXIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 1:	Segregated Equipment Drop	1.	Deposit equipment used at the site (tools, sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2:	Boot Cover and Glove Wash	2.	Scrub outer boot covers and gloves with decon solution or detergent and water.
Station 3:	Boot Cover and Glove Rinse	3.	Rinse off decon solution from station 2 using copious amounts of water.
Station 4:	Tape Removal	4.	Remove tape around boots and gloves and deposit in container with plastic liner.
Station 5:	Boot Cover Removal	5.	Remove boot covers and deposit in container with plastic liner.
Station 6:	Outer Glove Removal	6.	Remove outer gloves and deposit in container with plastic liner.
Station 7:	Suit and Safety Boot Wash	7.	Wash chemical-resistant splash suit, SCBA, gloves, and safety boots. Scrub with long-handled scrub brush and decon solution. Wrap SCBA regulator (if belt-mounted type) with plastic to keep out water. Wash backpack assembly with sponges or cloths.

APPENDIX 5.5, Continued

MAXIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 8:	Suit, SCBA, Boot, and Glove Rinse	8. Rinse off decon solution using copious amounts of water.
Station 9:	Tank Change	9. If worker leaves exclusion zone to change air tank, this is the last step in the decontamination procedure. The worker's air tank is exchanged. New outer gloves and boot covers are put on, and joints are taped. The worker returns to duty.
Station 10:	Safety Boot Removal	10. Remove safety boots and deposit in container with plastic liner.
Station 11:	SCBA Backpack Removal	11. While still wearing face piece, remove backpack and place on table. Disconnect hose from regulator valve.
Station 12:	Splash Suit Removal	12. With the assistance of a helper, remove splash suit. Deposit in container with plastic liner.
Station 13:	Inner Glove Wash	13. Wash inner gloves with decon solution.
Station 14:	Inner Glove Rinse	14. Rinse inner gloves with water.
Station 15:	Face Piece Removal	15. Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers.
Station 16:	Inner Glove Removal	16. Remove inner gloves and deposit in lined container.

APPENDIX 5.5, Concluded

MAXIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 17: Inner Clothing Removal	17. Remove inner clothing. Place in container with liner. Do not wear inner clothing away from the site, because there is a possibility that small amounts of contaminants might have been transferred in removing the outer clothing. Begin a gross alpha radiation survey, when applicable.
Station 18: Field Wash	18. Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Station 19: Redress	19. Put on clean clothes.

Sources: NIOSH, OSHA, USCG and EPA, October 1985.
U.S. EPA, November 1984.

APPENDIX 5.6

MINIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 1:	Equipment Drop	1.	Deposit equipment used at the site (tools,sampling devices and containers, monitoring instruments, radios, and clipboards) on plastic drop cloths. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.
Station 2:	Outer Garment, Boots, and Gloves Wash and Rinse	2.	Scrub outer boots, outer gloves, and chemical-resistant splash suit with decon solution or detergent water. Rinse off with water.
Station 3:	Outer Boot and Glove Removal	3.	Remove outer boots and gloves. Deposit in container with plastic liner.
Station 4:	Tank Change	4.	If worker leaves exclusive zone to change air tank, this is the last step in the decontamination procedure. The worker's air tank is exchanged. New outer gloves and boot covers are put on, and joints are taped. The worker returns to duty.
Station 5:	Boots, Gloves and Outer Garment Removal	5.	Boots, chemical-resistant splash suit, and inner gloves removed and deposited in separate containers lined with plastic.
Station 6:	SCBA Removal	6.	SCBA backpack and face piece are removed. Avoid touching face with fingers. SCBA is deposited on plastic sheets.
Station 7:	Field Wash	7.	Hands and face are thoroughly washed. Shower as soon as possible.

Sources: NIOSH, OSHA, USCG and EPA, October 1985.
U.S. EPA, November 1984.

STANDARD OPERATING PROCEDURE 2.1

PRESAMPLE PURGING OF WELLS

1. PURPOSE

To identify well-purging procedures for evacuation of stagnant water from the well bore and its replacement by groundwater in sufficient quantities so that a water sample representative of the formation of completion can be collected.

2. DISCUSSION

The choice of procedure and equipment for well evacuation depends on the Remedial Investigation Plan (RIP), the yield of the well, water depth, well size, and the type of water analysis. This procedure describes various methods for well evacuation. Collection and measurement of samples and the documentation of data should be performed as described in the associated procedures (see 3.1).

Peristaltic Pump

Using a peristaltic pump for well evacuation is particularly advantageous because the same system may be used for sample collection. In addition, the flow rate is easily controlled with a peristaltic pump. The pump can be used in wells of any diameter and nonplumb wells, and the pump is highly portable and readily available. However, peristaltic pumps can only be used in wells with a potentiometric level less than 25 ft below the land surface. Additionally, low pumping rates make it difficult to evacuate the wellbore in a reasonable amount of time. An electric power source is required, and there is a high likelihood of stripping the volatiles.

Bladder Pump

The bladder pump (Middelburg type or diaphragm) is a particularly good choice when the well depth is beyond the capability of the peristaltic pump. In addition, the relatively high pumping rate allows rapid well evacuation. Bladder pumps are portable, though the accessory equipment may be cumbersome. With deep purging, large volumes of gas and longer cycles are required. Operating time and expense are increased as a result.

Bailer

For shallow, small-diameter wells with low yields, evacuation of the well by bailer is recommended. Bailers are mechanically simple, lightweight and highly portable, constructed in many sizes, and require no external power source. Bailers are easily operated and cleaned and inexpensive. The primary disadvantage of bailers is their limited-volume purging capability, especially in deep wells where purging is labor and time consuming. Another disadvantage is that sampling personnel are directly exposed to contaminants.

Electric Submersible Pump

The submersible pump is commonly used for purging deep, large-diameter wells requiring high pumping rates. The pump is portable and self-contained except when auxiliary power sources are employed. The primary disadvantage is that the pump can be difficult to decontaminate and transport. Other disadvantages are damage caused by dry pumping, damage to the gears (when the water contains high levels of suspended soils), and the high cost of these large-capacity pumps.

Reciprocating Piston Submersible Pumps

The reciprocating piston submersible pump is a portable system for purging wells with water depths up to 500 ft. These pumps develop high pumping rates and can be operated in 2-inch-diameter wells. The system is operated by compressed gas (air or nitrogen) and driven by an air motor. The pump is self-priming, and the gas that drives the pump does not contact the purged water. The pump is constructed from stainless steel and can be decontaminated easily.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
2.2	Field Measurements on Ground and Surface Water Samples
2.3	Sampling Monitoring Wells with a Bladder Pump
2.4	Sampling Monitoring Wells with a Bucket-Type Bailer
2.5	Sampling Monitoring Wells with a Submersible Pump
2.6	Sampling Monitoring Wells with a Peristaltic Pump
3.1	Water Level Measurement
6.1	Health and Safety Monitoring of Combustible Gas Levels
6.2	Health and Safety Monitoring of Organic Vapors with a Photoionization Detector

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Have the site manager order the standard solutions for specific conductance and pH/alkalinity calibrations to be performed either before departing for the site or upon arrival at the site.

F. Consult with the site manager about purging techniques and the disposal of purged water and other sampling expendables.

G. Make arrangements to buy or lease an air compressor or bottled nitrogen.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Locate the monitoring wells to be sampled and the appropriate decontamination area. Locate the staging area and areas for managing purged water and expendable sampling materials. Check decontamination zones and barricades to public access. Plan to purge the wells, moving from the least contaminated to most contaminated.

B. Decontaminate the purging pump or bailer before taking the first sample and between sampling intervals (see SOP 1.6, General Equipment Decontamination, and the RIP).

3.3. Operation

A. Record all calculations and field measurements according to SOP 2.2, Field Measurements on Ground and Surface Water Samples.

B. Calculate the amount of water in the well casing with the formula shown below.

$$(pi) \times \frac{(d^2)}{4} \times (h_1 - h_2) \times 7.48 = \text{gallons per bore volume}$$

where

pi	=	3.1416
d	=	inner diameter of well casing (ft)
h_1	=	depth of well from top of well casing (ft)
h_2	=	depth to water from top of casing (determined in field) (ft)
bore volume	=	volume of water equivalent to the standing water in a well

C. Measure floating organic layer volume in the well. Slowly lower a bailer to the level of water in the well. Allow the bailer to fill gradually to approximately one-half of its capacity. Slowly retrieve the bailer and pour the sample into a clear glass beaker. Allow the sample to settle and measure the volume of floating organics. Record reading in the field notebook.

3.3.1. Peristaltic (Suction-Lift) Pump

The peristaltic pump is a self-priming, low-volume pump consisting of a rotor and ball-bearing rollers. Tubing inserted around the pump rotor is squeezed by the rollers as the rotor revolves. One end of the precleaned tubing is placed into the well while the other end is connected to a flow-through bath. As the rotor revolves, water is drawn (up to one gallon per minute) from the well.

For purging with a peristaltic pump, proceed as described below.

1. Using clean equipment, determine the total depth of the well and water level with an electric sounder or steel tape (see SOP 3.1, Water Level Measurement). Calculate the fluid volume in the casing, using the casing volume or the bore volume (the RIP may require considering the latter).

2. Determine the depth from the casing top to the midpoint of the screen or well section open to aquifer. Consult the well completion and water level measurement records or sound for the bottom.

3. If depth to midpoint of screen exceeds 25 ft, choose an alternate system.

4. Lower intake into the well a short distance below the water level and begin water removal. Collect or dispose of the purged water in containers of the type specified in the RIP. Lower suction intake to maintain submergence and allow for successive purging of the water column.

5. Monitor the air above the wellhead (as specified in SOP 6.1, Health and Safety Monitoring of Combustible Gas Levels; SOP 6.2, Health and Safety Monitoring of Organic Vapors with a Photoionization Detector; and SOP 6.3, Health and Safety Monitoring of Organic Vapors with a Flame Ionization protector) to determine the potential for explosion, fire, and any toxic effect on workers.

6. Record the amount of water purged and discharge rates. A calibrated bucket and stopwatch are most commonly used to obtain this measurement.

7. Purging procedures will follow the Rocky Flats Plant current "L" procedures (see Appendix 5.2).

8. After pumping, monitor the water level recovery. The recovery rate may be useful in determining the sample rate.

9. Decontaminate the tubing and fittings according to SOP 1.6, General Equipment Decontamination.

3.3.2. Bladder (Gas-Operated, Squeeze-Type) Pump

Bladder pumps consist of a membrane enclosed in stainless steel housing. Water enters the membrane through a lower check valve; compressed gas is injected into the cavity between the housing and bladder. Water is transported through an upper check valve and into a discharge line. The process is repeated to cycle the water to the surface and into the flow-through bath.

For purging with a bladder pump, proceed as described below.

1. Using decontaminated equipment, determine the total depth of the well and the water level with an electronic level indicator (see SOP 3.1, Water Level Measurement). Then calculate the fluid volume in the well casing (either casing or bore volume).

2. Determine the depth from the casing top to the midpoint of the screen or well section open to aquifer (consult well completion and water level measurement records). If two or more screen sections are present, determine at which section to set intake and note in logbook.

3. Lower pump assembly into the well until the pump is near the middle of the screened interval.

4. Attach compressed gas and discharge lines. Adjust cycle.

5. Begin water removal; collect or dispose of the purged water in containers of the type specified in the RIP.

6. Monitor the air above the wellhead according to the RIP to determine the potential for fire, explosion, and any toxic effect on workers.

7. Measure the rate of discharge frequently (every two gallons). A calibrated bucket and stopwatch are commonly used to obtain this measurement.

8. Purging procedures will follow the Rocky Flats Plant current "L" procedures (see Appendix 5.2).

9. After pumping, monitor the water level recovery. The recovery rate may be useful in determining the sample rate.

10. Decontaminate the pump assembly (see SOP 1.6, General Equipment Decontamination).

3.3.3. Bailer

Water is removed from the bore by a vessel of known volume. The vessel fills with water, and the unit is retrieved with a line or rope.

For purging with a bailer, proceed as described below.

1. Using decontaminated equipment, determine the total depth of the well and the water level with an electric sounder or steel tape (see SOP 3.1, Water Level Measurement). Then calculate the fluid volume in the well casing (either casing or bore volume). If considering the amount of water in the well casing and the filter pack is required, consult the RIP for the appropriate calculations.

2. Lower the bailer into the well and begin water removal. Collect or dispose of purged water in containers of the type specified in the RIP.

3. The air above the wellhead must be monitored (as specified by SOP 6.1, Health and Safety Monitoring of Combustible Gas Levels; SOP 6.2, Health and Safety Monitoring of Organic Vapors with a Photoionization Detector; and SOP 6.3, Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector) to determine the potential for explosion, fire, and any toxic effect on workers.

4. Record the amount of water purged and discharge rates frequently (every two gallons). A calibrated bucket and stopwatch are commonly used to obtain this measurement.

5. Purging procedures will follow the Rocky Flats Plant current "L" procedures (see Appendix 5.2).

6. Once the well has been bailed, monitor the water level recovery. The recovery rate may be useful in determining the sampling rate.

7. Decontaminate the bailer (see SOP 1.6, General Equipment Decontamination).

3.3.4. Electric and Reciprocating Piston Submersible Pumps

The pump assembly is suspended from the discharge tubing and submerged in the well. Water is transported through the discharge tube to the surface by centrifugal or piston action. A portable generator (or battery) is used to provide a power source for the electric pump and a winch in some cases. A portable air compressor is used to drive the piston-type pump.

For purging with a submersible pump, proceed as described below.

1. Purge the well as prescribed in steps 1-3 and 5-9 in method 3.3.1.

2. Decontaminate the pump assembly (see SOP 1.6, General Equipment Decontamination).

3.3.5 Dedicated Pump System

The dedicated pump system will consist of an air-actuated bladder pump with downward flow checking valves on the inlet to the inside of the bladder and on the tubing above the outlet from the inside of the bladder. Air is delivered to the outside of the bladder and pressure is maintained long enough that the bladder is compressed and water inside it is forced into the discharge tubing. Water is kept from exiting the bottom of the pump by the lower check valve. The air pressure is vented to surface through the same pressurizing tube (requiring a time dependent on length of tubing, required air pressure, and depth of submergence of the pump). Water forced into the discharge tubing is held by the upper check valve. The cycle is repeated until discharge reaches the surface and purging begins. Because of this pumping mechanism, the discharge is delivered to the surface in cyclic slugs, but the pressurizing air is never in contact with the water.

The upper check valve has a small-diameter bypass so that water in the discharge tubing will drain back into well and not freeze.

1. Attach compressor to Pump Pressure Inlet on controller (use oil-less compressor to protect pneumatic logic components inside controller).

2. Connect red air hose between well cap and Pump Supply on controller.

3. Position Refill and Discharge knobs to center position (12 o'clock) and start compressor. Record the time at the start of pumping in the field notebook.

4. Set gas pressure level to a pressure sufficient to lift the column of water in the discharge tubing plus 30 psi, but do not exceed 125 psi total.

5. Adjust Discharge knob so that venting occurs at the end of the slug discharge.

6. Decrease Refill cycle time until volume discharged in each cycle begins to decrease. If decrease is immediate, lengthen both Refill and Discharge cycle times and repeat steps 5 and 6.

7. Measure volume produced in a container of known volume (e.g., plastic trash can or plastic bucket).

8. Continue pumping until the appropriate volume has been purged. Record time at end of pumping as well as the total volume pumped in the field notebook and on the Field Water Quality Data Sheet.

9. Measure and record water level at the end of pumping.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to the presampling conditions specified in the RIP.

3.4.2. Documentation

A. Record cleanup procedures and any uncompleted work (like site restoration or incomplete purging) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to equipment manager and report incidents of malfunction or damage.

4. SOURCES

Barcelona, M. J., J. P. Gibb, J. A. Helfrich, and E. E. Garske. 1985. "Practical Guide to Groundwater Sampling." U.S. Environmental Protection Agency report EPA/600/2-85/104. Washington, D.C.: U.S. Government Printing Office.

Korte, N., and P. Kearl. 1984. Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: First Edition. U.S. Department of Energy, Grand Junction, Colorado.

Morrison, R.D. 1983. "Ground Water Monitoring Technology, Procedures, Equipment and Applications." TIMCO Manufacturing, Inc., 85-90, Evanston, Illinois.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Current Rocky Flats Plant Procedures for Groundwater Monitoring Program

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

_______ Purging pump or bailer

_______ Water level sounding device

_______ Calculator

_______ Conductivity meter

_______ pH meter

_______ Digital titration kit

_______ Calibration solutions

_______ Air compressor or bottled nitrogen (as needed)

APPENDIX 5.2

ROCKWELL INTERNATIONAL

SAMPLING PROCEDURE FOR ROUTINE GROUND MONITORING PROGRAM

APPENDIX 5.2, Continued

ROCKY FLATS PLANT

COPY NO:

SAMPLING PROCEDURE FOR GROUNDWATER
MONITORING PROGRAM

L-6213-C

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This procedure contains consecutively numbered pages 1 through 41.

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SAMPLING PROCEDURE FOR GROUNDWATER MONITORING PROGRAM

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L-6213-C-2

1. INTRODUCTION

This procedure is used for RCRA ground water monitoring wells at the Rocky Flats Plant. The procedure provides for:

- Equipment Decontamination
- Water Level Measurement
- Well Purging and Containment
- Field Water Quality Measurements
- Sample Collection, Bottling and Preservation
- Quality Assurance/Quality Control
- Documentation and Data Management

Sampling is done on a quarterly basis using the calendar year. Water level measurements are taken on a monthly basis at each well location.

Proper protective clothing must be worn by the individuals sampling and purging at the well site. This includes Tyvex® coveralls, surgeons and/or neoprene gloves, rubber shoe coverings (may be exluded if Tyvex® have feet), and safety glasses.

The Tyvex® coveralls, gloves, and shoe coverings should be discarded after use at each well to prevent cross contamination from well to well.

1. HAZARDS, SAFETY, AND SAFEGUARDS CONTROL

1.1 The Material Hazard Rating (MHR) for each chemical used routinely in this procedure is listed below. The MHR listed will be either those used by the National Fire Protection Association (NFPA) or those made by Rocky Flats Testing (RFT). The rating numbers show increasing hazard from a 0 for no unusual hazards to a 4 for severe hazards. The first number in this grouping describes the health hazard, the second the fire hazard, and the third the reactivity hazard. For further details on the description of each of these hazards, check the Material Hazard Manual or Material Safety Data Sheets.

	H	F	R	Remarks
Sulfuric acid (H_2SO_4) (concentrated)	3	0	2	Corrosive. Causes severe burns. Powerful oxidizing and dehydrating agent. Rapid heating and splattering when mixed with water. Capable igniting finely divided combustible materials. Hydrogen is evolved in contact with many metals. Hazardous in contact with carbides, chlorates, fulminates, nitrates, picrates, powdered metals, and combustibles. Add acid to water when diluting. Speeds reaction and reduces reaction temperatures of oxidants with combustibles due to heating and dehydration.
10M Sodium Hydroxide (NaOH)	3	0	1	Caustic. Reacts with water to produce heat and steam. In contact with combustibles and moisture, it may heat enough to ignite.

SAMPLING PROCEDURE FOR GROUNDWATER MONITORING PROGRAM

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APPENDIX 5.2, Continued

	H	F	R	Remarks
Nitric Acid - Trace Metal Quality (HNO_3) (Concentrated)	3	0	0	Nitric acid is a powerful oxidant that reacts violently with organics, reductants, and combustibles and may cause explosions or fires. It increases the flammability of these materials and can also cause their ignition. Causes skin burns and reacts to form toxic gases. Inhalation may result in delayed (fatal) lung edema. Reacts violently with niobium, zirconium, powdered germanium, uranium fires, lithium or other alkali metals, carbides, cyanides, and hydrogen cyanide. May explode when mixed with miscible organics such as acetone, alcohols, glycerine, acetic acid, and glycols. Can form explosive mixtures with ether, toluene, and cyclic ketones. Reactive with chromic acid, hydrocyanic acid, and hydrogen sulfide.
pH Buffer	1	0	1	Contains alkali hydrogen phosphates and dihydrogen phosphates.
Potassium Chloride (KCl)	1	0	0	- NO REMARKS -
Alconox Soap	2	1	1	- NO REMARKS -

[illegible].2 Samplers must log in and out of the Buffer Zone of the plant through the 900 and 920 guard posts. A set of keys is picked up at each of the guard posts to open various gates in the Buffer Zone. The Buffer Zone includes all areas outside the inside perimeter fenced area.

3. SPECIAL EQUIPMENT

3.1 Standards Lab calibrated pH meter.

3.2 Standards Lab calibrated conductivity - temperature meter.

3.3 Electric water level sounder. This device is used to measure the total depth (TD) and water level (WL) of the well. The cable is graduated to indicate the length of cable in the well.

3.4 Sampling and/or purging devices:

3.4.1 Dedicated pump system. (e.g., Well Wizard®). This consists of an air actuated bladder pump that will be dedicated to specific wells.

3.4.2 Positive displacement pump (e.g., Bennett). This may be used to pump wells with total depths over 50 feet and/or storage volumes of over 75 liters.

3.4.3 Stainless steel bailers. Stainless steel bailers may be used to bail wells with total depths below 50 feet and/or storage volumes under 75 liters. They may also be used when dedicated or portable pump systems are unavailable.

3.5 Oil-less air compressor.

3.6 Tape measure.

3.7 Field logbook.

3.8 Watch.

3.9 Calculator.

3.10 Communication device.

3.11 Portable filtering apparatus (e.g., Geotech).

3.12 Brushes.

3.13 Graduated bucket, 5 gallon or larger.

3.14 Coolers.

3.15 Blue-ice packs.

3.16 Squirt bottles.

3.17 Decon tubs.

3.18 Decon spray tanks.

3.19 Containers for the containment of purge and developing water.

3.20 Various tools including: Screw drivers, scissors, knife, hammer, etc.

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4. MATERIALS

4.1 Chemicals and Reagents

4.1.1 Concentrated sulfuric acid (H_2SO_4), reagent grade quality.

4.1.2 Concentrated nitric acid (HNO_3), trace metal quality.

4.1.3 10M sodium hydroxide (NaOH), reagent grade quality. Dissolve 400g NaOH in 800 ml deionized water in a 1 liter volumetric flask. Bring up to volume and store in 1 liter plastic bottle.

4.1.4 Deionized water.

4.1.5 Alconox Solution: Dissolve 0.5 cup of alconox powder per 3 gallon of deionized or distilled water.

4.1.6 pH Buffers: Follow directions on specific buffer bottle regarding preparation. Two buffers, one in the 4.0-7.0 range, and the other in the 3.0-10.0 range are needed. Place buffers in sample cooler for storage. These are made up fresh weekly in the laboratory and verified on a lab pH meter. Record pH value on buffer bottle.

4.1.7 Conductivity Standard: Dissolve 0.7459 g KCl (dried for one hour in a 110°C oven) in 1 liter of deionized water. Lower the temperature of the standard by cooling in ice bath to 10°C. Immediately take the measurement of the standard on the laboratory calibrated conductivity meter and record value on calibration sticker on bottle of standard. Place standard in sample cooler for storage. This is made fresh weekly. The standard value is dependent on the temperature of the sample at time of measurement.

4.2 <u>Consumable Materials</u>

4.2.1 Pen.

4.2.2 Polypropylene rope.

4.2.3 Plastic sheeting.

4.2.4 Surgeons gloves.

4.2.5 Neoprene gloves.

4.2.6 Tyvex® coveralls.

4.2.7 Shoe coverings, or booties.

4.2.8 Sample bottles.

4.2.9 Batteries (sizes C, D, and AA).

4.2.10 Chain-of-Custody sheets.

4.2.11 Filter media (Geotech glass fiber, 125 mm, #24 pore size and Geotech Cellulose Acetate, 142 mm, 0.45 μm pore size or equivalent).

5. STANDARDIZATION AND CALIBRATION

The pH meter, conductivity-temperature meter, and water level sounder will be calibrated by the Standards Lab on a quarterly basis. The equipment should be kept clean and protected from temperature extremes.

5.1 Calibration of pH Meter with Buffers in the Field

Calibration of the meter will be performed prior to sampling of the well. Calibration checks will be performed during the sampling if sampling takes past 30 minutes of time.

5.1.1 Turn on meter and check battery.

5.1.2 Place pH buffers from cooler into labeled plastic beakers.

5.1.3 Remove boot from electrode. Rinse probe with deionized water.

5.1.4 Immerse bulb in upper pH buffer, and while stirring probe adjust calibration knob to correct reading. Record reading in logbook.

5.1.5 Rinse probe with deionized water.

5.1.6 Immerse bulb in lower pH buffer and record reading in logbook. Do not readjust calibration knob. This is simply a check of calibration.

5.1.7 Rinse bulb with deionized water.

5.1.8 Buffer solutions may be added back into standard bottle after use. Dispose of spent buffer solutions at the end of each day.

5.2 Calibration of Conductivity Meter with KCl Standard in the Field

Calibration of the meter will be performed prior to sampling of the well. Calibration checks will be performed during the sampling if sampling takes past 30 minutes of time or the instrument has been transported.

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5.2.1 Turn on meter.

5.2.2 Place conductivity standard from cooler into labeled plastic beaker.

5.2.3 Rinse conductivity probe and temperature probe with deionized water.

5.2.4 Immerse both probes into standard and adjust temperature compensate knob to correct standard reading for the temperature of the standard. Record both temperature and conductivity readings in a field logbook.

The specific conductance of the solution is as follows for meters without temperature compensation:

Temperature °C	Spec Conductance in umhos/cm
7	947
8	971
9	995
10	1020
11	1045
12	1070
13	1095
14	1121
15	1147
16	1173
17	1199
18	1225
19	1251
20	1278
21	1305
22	1332
23	1359
24	1386
25	1413

5.2.5 The standard solution may be added back into the standard bottle after use. Dispose of the spent standard solution at the end of each day.

5.3 Due to temperature fluxuations in the field, the pH meter must calibrate to within 0.2 S.U. of the buffer solutions and the conductivity meter to within 5% of the temperature compensated standard KCl value. If the meters cannot be adjusted accordingly, then they must be returned to Standards Lab for calibration.

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6. OPERATING INSTRUCTIONS

Appropriate clothing and gloves need to be worn to prevent contamination of equipment and personnel. This also prevents cross contamination when traveling from one well to another. The person handling the down hole equipment, including pump and compressor, will be clothed in white Tyvex® coveralls, booties, and surgeons gloves beneath Neoprene gloves. The other person will have surgeons gloves on, and properly dispose of the purge water. In addition, he is responsible for the calibration/checks and measurements of field instruments and parameters and documentation in the field logbook. All clothing should be removed and placed in the trash before traveling to the next well.

6.1 <u>Equipment Decontamination</u> (Chemical decon)

Sampling and purging equipment will be decontaminated after each use to minimize cross contamination between wells. All decontamination (decon) will be performed with one person handling all the equipment before cleaning, and the other person handling the equipment after cleaning. Both people will wear new clean surgeons gloves. Decon includes an alkaline detergent wash followed by a deionized water rinse. Spent decon solutions and rinse waters from containment wells are contained and disposed of in the laboratory process waste.

6.1.1 Decontamination of the water level sounder should be performed after each reading and stored in a clean plastic bag.

After the reading has been taken, decon the sounder directly out of the well. One person should wind the sounder on the reel while the other person wipes it with a Kimwipe® saturated in alconox solution, followed by a Kimwipe® saturated in deionized water.

6.1.2 Decontamination of the bailer should be performed after each use unless it is to be re-used for additional purging or sampling of the same well. In such a case the bailer should be placed in a clean plastic bag, sealed and labeled for the specific well.

After use of the bailer is complete, disassemble it and decon each part, using a brush and alconox solution. Then rinse each part with deionized water and reassemble. Store the bailer in a proper container.

6.1.3 Decontamination of the portable positive displacement (Bennett) pump should be performed after each use. Decon the pump directly out of the well. One person should wind the pump on the reel while the other person rinses it with alconox solution, followed by deionized water.

After being completely deconed, place the pump-head in a five gallon container of deionized water and pump 5 gallons of water through to clean the inside tubing.

6.1.4 External decontamination of the sample bottles should be performed after they have been filled and labeled only when sampling at a containment well. Covering of the label with plastic tape may be needed to prevent running of ink on label.

Rinse each bottle with alconox solution followed by deionized water. Place the bottles in cooler.

6.2 Water Level Measurement

An accurate measurement of the depth of the water in a well is needed to monitor seasonal fluctuations of water levels and to calculate the wellbore storage volume to be purged from a well before water quality sample collection. Each well is capped and locked for security purposes.

Some wells may contain volatile organic vapors that can be trapped in the well casing over time. A photoionizing instrument will be used to take HNu readings on a quarterly basis. These readings will be done by the monthly water level measurement team. A list of the wells that gave HNu readings above 1.0 ppm is listed in Table III, Containment Wells.

6.2.1 Stand upwind from the well casing to unlock and remove the well cap. Place the lock and cap next to the well casing. Allow the well to stand open for a period of at least five minutes. This would allow potential organic vapors to dissipate.

6.2.2 Record the following in the logbook:

- Well location
- Well identification number
- Device number
- Date and time

6.2.3 Turn on well sounder, check battery, and lower cable into well until presence of water is indicated.

6.2.4 Hold cable so thumb and index finger are touching the top of casing when probe just enters water (alarm will sound). Use the north rim of the inner casing for the depth to water reference point.

6.2.5 Raise cable until alarm stops (i.e., probe is just above water level). Lower cable until alarm sounds again. Check to see if thumb and index finger are at the same location as before. Repeat one more time for a final verification.

6.2.6 Read the measurement off the cable to the nearest half of the lowest dimension (e.g., 0.05 feet). Record the water level (WL) in the logbook.

6.2.7 Continue lowering the cable into the hole to determine the total depth (TD). When slack in the cable occurs, pull the cable up until slack is gone.

6.2.8 Hold cable the same as for water level and take measurement at the north rim of the inner casing for reference point. Repeat one more time for a final verification.

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6.2.9 Read the measurement off the cable to the nearest half of the lowest dimension (e.g., 0.05 feet). Record the TD in the logbook.

6.2.10 Decon the sounder as stated in Section 6.1.1.

6.3 Well Purging

The water standing in the well may have different chemical characteristics than the water in the formation because of volatilization of constituents and/or changes in oxidation and pH conditions. For this reason, the water standing in the well must be removed and water representative of the formation water brought into the well before the actual sample is collected. This is known as well purging.

Purging will consist of removing a minimum of three wellbore storage volumes from high production wells or a minimum of one wellbore storage volume from low production wells. A high production well is a well from which three wellbore storage volumes can be removed without stopping to wait for the well to recharge. When volume drops below 0.5 liters, the well is done purging. A low production well is a well from which three wellbore storage volumes cannot be removed in eight hours due to insufficient inflow to the well from the formation. Purging is a continuous process and only takes place until three volumes of water are removed or the well goes dry.

Wellbore storage volume is the volume of water standing inside the well casing, i.e., the distance between the water level and the bottom of the casing (length of the water column in the well), multiplied by the inner cross sectional area of the casing.

6.3.1 Calculate the wellbore storage volume using the formula below:

Wellbore Storage Volume (liters) = (TD-WL)*(A)

WSV = well storage volumes (liters)

TD = total depth (feet)

WL = water level (feet)

A = cross sectional area of well (multiplier) (liters/foot)

- = 0.619 for 2" well
- = 1.395 for 3" well
- = 2.478 for 4" well
- = 5.586 for 6" well

Round the well storage volume to one significant figure to the right of the decimal (i.e., a tenth of a liter).

6.3.1.1 A well is considered dry if before purging, the wellbore storage volume is below two liters calculated volume.

6.3.1.2 Multiply the wellbore storage volume by three to get the maximum volume of water to be purged from the well.

6.3.1.3 Record calculations and values for: TD, WL, WSV, and A in the field notebook. Record to 2 significant figures if value is under 10 liters, to 3 significant figures if value is over 10 liters, and to 4 figures if value is over 100 liters.

6.3.2 Remove the appropriate number of calculated wellbore storage volumes of water from the well using the dedicated pump, bailer, or portable sampling pump. Regardless of the type of equipment used to purge the well, record the total volume purged and the time when purging begins and ends. Purging is a continuous process and only takes place until three volumes of water are removed, or the well goes dry.

Some wells are defined as containment wells due to significant concentration of organics being found in their water. The water from these wells are contained for special disposal. If purge water is to be contained, according to the list of containment wells located in Table III, then it is to be poured into holding containers once the volume has been measured. These containers are brought back to the lab for disposal of the water into the process drain system.

6.3.3 The dedicated pump system consists of an air actuated bladder pump with downward flow checking valves on the inlet to the inside of the bladder, and on the tubing above the outlet from the inside of the bladder. Air is pressed on to the outside of the bladder and pressure is maintained long enough that the bladder is compressed and water inside it is forced into the discharge tubing. Water is kept from exiting the bottom or the pump by the lower check valve. The air pressure is vented to the surface through the same pressurizing tube. Water forced into the discharge tubing is held by the upper check valve. The cycle is repeated and eventually water reaches the surface and pumping begins. The water is discharged to the surface in cyclic slugs. The pressurizing air is never in contact with the water. The upper check valve has a small diameter bypass to allow drainage of water from the discharge tube. This will drain water from the pump head.

When installing the dedicated pump into the well, position the screen 6"-8" off the the bottom. This will prevent plugging of the screen by silt at the bottom of the well.

6.3.3.1 Attach the compressor to the pump pressure inlet on the controller. (Use oil-less compressor to protect pneumatic logic components inside the controller.)

6.3.3.2 Connect the red air hose between well cap and the pump supply on the controller.

6.3.3.3 Start the compressor. Record start time of purging in the field logbook.

6.3.3.4 Set air pressure level to a pressure sufficient to lift the column of water in the discharge tubing. Then increase the pressure an additional 30 PSI, but do not exceed 125 PSI, total pressure.

6.3.3.5 Adjust the discharge knob so that venting occurs at the end of the slug discharge.

6.3.3.6 Decrease the refill cycle time until the volume discharge in each cycle begins to decrease. If decrease is immediate, lengthen both the refill and discharge cycle times, and repeat Steps 6.3.3.5 and 6.3.3.6.

6.3.3.7 Measure volume produced in a container of known volume (e.g., plastic graduated bucket).

6.3.3.8 Continue pumping until the appropriate volume has been purged. Record time at the end of pumping and the total volume pumped in the field logbook.

6.3.4 Bailing with a stainless steel bailer will be done when either a dedicated pump does not exist, the dedicated pump is inoperable, or the wellbore storage volume is less than 75 liters for all three volumes.

Appropriate clothing and gloves need to be worn as stated in Step 6.3.3.1.

6.3.4.1 A sheet of plastic will be placed over the casing when purging wells where the rope cannot be coiled in the person's hands. Cut a hole in the plastic for the casing and spread sheet on the ground around the well. The plastic and equipment should be arranged in such a manner as to enable the sampler using the downhole equipment to do all work while standing on the plastic. The plastic is to keep all equipment clean and soil free. All workers will only walk on the plastic with booties which have never touched the ground.

6.3.4.2 Remove bailer from its holder and inspect check valve, top bail, and cord which the rope ties to. (All personnel should be dressed in the appropriate clothing and gloves before handling any equipment). If any components are loose or damaged, replace them. Decontaminate equipment if any new parts are used. Do not allow bailer or rope to contact anything but clean plastic.

6.3.4.3 Tie a figure-8 knot with the rope onto the cord of the bailer. First, make a loop 6" in diameter and twist twice to form 2 small loops around base of large 6" loop with excess rope. Second, thread end of rope through 6" loop (see diagram) and out over to cord on bailer, this forms the figure 8. Third, thread end of rope through bailer cord and back through figure 8 in reverse order. Follow end of rope through along the original rope in reverse order until you have passed through the 2 small original loops around the base. This should bring the end of the rope back to the spool of rope. Pull tight.

6.3.4.5 Record start time in field notebook.

Slowly lower bailer into well to just below the surface of the water. Do not drop bailer into well at high speed because the check valve may dislodge or become damaged. Fill the bailer with water and hoist to surface coiling rope into hands or onto plastic. Pull directly up on rope when coiling. Do not allow rope to rub against casing when pulling up. Do not allow rope to fall off of plastic. If the rope does get soiled, the rope must be changed before bailing again.

6.3.4.6 Empty bailer into the graduated container of known volume. Continue bailing until appropriate volume has been purged, as determined by volume in container. If purge water is to be contained the same process stated in Step 6.3.2 should be followed. Record time at the end of purging and total volume bailed in the field notebook.

Decontamination, described in Section 6.1.2, will be performed at this time. If bailer will be re-used later at the sample well, it should be placed in a clean plastic bag, sealed and labeled for the specific well.

6.3.5 A portable positive displacement pump can be used if desired to purge a well. This is recommended when either a dedicated pump does not exist, the dedicated pump is inoperable, or the wellbore storage volume is greater than practical for bailing (i.e., 75 liters for all three volumes).

Appropriate clothing and gloves need to be worn as stated in Step 6.3.3.1.

6.3.5.1 Place clean decontaminated pump approximately one foot above the bottom of the well. Place the uphole end of the discharge in the graduated container of known volume.

Record start time for pumping in the field notebook.

6.3.3.2 Connect compressor to pump controller. Turn on compressor and pump appropriate volume as measured in graduated container.

If purge water is to be contained, the same process stated in Step 6.3.2 should be followed. Record time at the end of purging and total volume purged in the field notebook when purging is complete.

Decontamination, as described in Section 6.1.3, will be performed at this time.

6.4 Field Water Quality Measurements

Calibration and standardization should be performed according to Section 5 of this procedure before each field water quality sample is taken during sampling of the wells. Field water quality samples are a portion of the well water taken to be measured for temperature, pH and conductivity.

6.4.1 Rinse a 250 ml beaker or larger with deionized water and collect a sample, filling the beaker approximately half full.

6.4.2 Place the temperature probe in the beaker. Stir the sample with the probe to allow a stable reading. Read temperature to the nearest degree. Record reading in the field logbook.

6.4.3 Place pH probe and conductivity probe in the beaker.

6.4.4 Stir the sample with the pH electrode to allow a stable reading. Read pH to the nearest tenth of a pH unit. Record reading in the field logbook.

6.4.5 Stir the sample with the conductivity probe to allow a stable reading. Read conductivity to two significant figures. Record reading in the field logbook.

6.4.6 Rinse all probes and beaker with deionized water.

6.4.7 Leave meters on if more samples are to be taken, otherwise turn meters off.

6.5 Sample Collection, Bottling and Preservation

For purposes of sample collection, a technically dry well is one that does not recharge sufficiently to provide at least 2 liters of sample within 24 hours of purging. A well may be sampled for partial analyses as long as at least two liters are present in the well each 24 hours. If after 24 hours the water volume is below two liters then the well is considered dry and only the Volatile Organic (VOA) samples will be analyzed. If a full set of samples cannot be collected in three days, then the well will not be sampled for the remaining analytes for the current quarter.

Samples will be collected with the dedicated pump when possible. If a bailer or portable pump was used to purge the well then a bailer will be used to sample. The portable pumps will be used for purging only and will not be used to sample a well.

6.5.1 Preparing sample bottles will be done in the lab prior to going into the field.

Preservation and sample size for each parameter(s) will be as follows:

Parameter	Container Type	Volume	Preservation
Volatile Organics (VOA)	Septum Vial	2-40 ml	Cool 4°C
Total Dissolved Solids, (TDS) Alkalinity, (Alk), Chloride (Cl^-), Sulfate (SO_4^{--}) (label as CSTA)	Plastic	1-liter	Cool 4°C
Metals - filtered	Glass	1-liter	5 ml HNO_3

Parameter	Container Type	Volume	Preservation
Nitrate as N (NO_3 -N)	Plastic	125 ml	H_2SO_4 to pH<2
Gross Alpha & Gross Beta - filtered (G-A&B)	Plastic	250 ml	HNO_3 to pH <2
Tritium (H^3)	Amber Glass	250 ml	None
Pu-239, Am-241, U-234, 235 238-filtered (Pu-Am-U)	Plastic	4-liter	HNO_3 to pH<2
Cyanide (CN^-)*	Plastic	1-liter	10M NaOH to pH >12
Cs-137 - filtered*	Plastic	1-liter	HNO_3 pH <2
Sr-90 - filtered*	Plastic	1-liter	HNO_3 pH <2

*Sampled only when specially requested.

6.5.1.1 Each sample bottle will be labeled with the following information:

Well number/sample location
Parameter
Date/Time sampled
Preservation

6.5.1.2 Sample bottles will be placed in a cooler with blue ice.

6.5.1.3 Chain of Custody forms will be picked up in the lab and filled out in the field at each well site (Figure 1, page 36).

6.5.2 The samples should be collected immediately after purging if possible. If the well is essentially dry after purging, measure the water level in the well on a periodic basis. Collect volatile organic samples within four hours of purging. Collect the rest of the samples as soon as there is sufficient volume in the well to fill sample bottles (at least two liters within 24 hours, see Section 6.5).

Many times a well does not produce enough water to allow for analysis of all the requested parameters. Therefore, collect samples in the following order:

- VOAs
- Pu-U-Am
- NO_3-N
- Metals
- Gross A & B
- H^3
- TDTA
- CN*
- Cs-137*
- Sr-90*

*When requested.

6.5.3 The appropriate clothing and gloves need to be worn to prevent contamination of equipment and personnel during collection of samples.

6.5.3.1 Prior to sample collection for all samples other than volatile organics, take water level measurement with the well sounder. Stand upwind from the well casing to unlock and remove the well cap. Place the lock and cap next to the well casing. Allow the well to stand open for a period of five minutes. This will allow for potential organic vapors to dissipate. The volatile organic sample is always taken within four hours of purging and therefore a water level measurement is not necessary.

Record the water level measurement in the field notebook and calculate the well storage volume to determine volume available to sample.

6.5.3.2 Record time of sampling and date on each sample bottle and in field notebook.

6.5.3.3 When filling VOA bottles, fill each vial to overflowing with sample. Carefully place cap on the vial so that air is not captured, and tighten. Invert vial and tap lightly. If air bubbles are observed, repeat process. To prevent aeration, the sample bottle should be filled with the vial tilted at an angle.

6.5.3.4 The remainder of the sample set is collected in two 4-liter cubitainers. The first container will provide the necessary water to fill bottles for Pu, U, Am, and NO_3-N analyses. The second container will provide the necessary water to fill bottles for metals, gross alpha and beta, tritium, chloride, sulfate, TDS, and alkalinity analyses.

The first Field Water Quality measurement is taken before the first cubitainer is filled. The second measurement is taken after the first cubitainer is three quarters full. The third measurement is taken when the first cubitainer is full and the second is half full. The final measurement is taken after the second cubitainer is full.

Each cubitainer should be labeled with site location, time, date, and NP (for No Preservation).

6.5.3.5 Metal and radionuclide (Pu, U, Am, Gross Alpha and Beta, and Cs-137) samples are filtered within four hours of sampling with a portable filtering pump in the lab using a prefilter followed by a 0.45 um filter. The samples may be filtered in the field if the four hour time limit will be exceeded. The time of filtration is recorded in the logbook and sample log sheets.

The apparatus is taken apart and the 0.45 um filter is placed in first, then the prefilter followed by the screen covers. Filters may be changed periodically during the process. Use them as needed to speed up the process.

The unfiltered sample in a 5 to 6 liter aliquot, is placed in unpreserved subcontainers or bottles first (see Section 6.5.3.3). Then after filtering, the filtered sample is placed in preserved bottles. Do not place unfiltered sample in preserved bottles.

6.5.3.6 Fill sample bottles from the two containers in Section 6.5.3.4.

6.5.3.7 Complete Chain of Custody form and indicate the time, date, well number, and number of bottles sampled.

6.5.3.8 Decon sample bottles as described in 6.1.4 and place in sample cooler for trip back to lab. Samples should be delivered to lab within 4 hours of collection.

6.6 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) will be maintained for both field sampling activities and laboratory analyses.

6.6.1 The field sampling QA/QC program will include daily calibration of field instruments, routine maintenance of equipment, quality control samples, deconing of equipment, area dedicated equipment, chain-of-custody, etc.

6.6.1.1 Trip blanks will be taken each time a sample set is taken. They will consist of a full set of sample bottles filled with deionized water from the lab. These samples will be transported in coolers out to the sampling sites and back to the lab for analysis. At no time after their preparation are the sample bottles opened before they reach the laboratory.

6.6.1.2 Field blanks will be taken each time a sample set is taken. The field blanks are defined as samples obtained by running deionized water through sample collection equipment (bailer, pump, filter apparatus, etc.) after decontamination, and placing it in the appropriate sample containers for analysis. These samples will be used to determine if decontamination procedures have been sufficient to insure the integrity of field blanks. They should be collected, stored and shipped with the other samples.

6.6.1.3 Duplicate samples will be taken once per week. These consist of a second full set of sample bottles being filled from a well currently being sampled. They will be labeled with the Well Identification-Dup and transported in coolers back to the lab for analysis.

6.6.2 A maintenance log will be maintained to document equipment maintenance and calibration of instruments by the Standards Laboratory. Daily calibrations will be kept in the field notebook (See Section 6.4).

6.6.3 This procedure is auditable by the General Laboratory, Health, Safety and Environment (HS&E), the RCRA/CERCLA program office, and other organizations.

6.6.3.1 Formal audit reports will be documented in the QA/QC files. Formal memoranda documenting deviations from the procedures in this document will be prepared and corrective actions will be documented by the General Laboratory management.

7. CALCULATIONS

7.1 Field calculations of the wellbore storage volume will be computed and logged in the field logbook. They will include units being used and the correct number of significant figures (See Section 6.3.1).

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Example: Well storage volume

A = Cross-sectional area (multiplier) of the well = 0.619 l/ft for 2" well

TD = Total Depth (ft) 101.4
WL = Water Level (ft) 68.2
33.2 ft.

33.2 ft x 0.619 l/ft = 20.6 liters = 1 storage volume

3 storage volumes = 61.8 liters

8.4 The following will be logged in the field notebook during sampling activities:

- Device used to sample
- Start time/end time of sampling
- Field parameters (i.e., pH, conductivity, temperature)
- Time for each parameter sampled
- Water level before sampling = Recharge volume
- Water description
- Time of filtration
- Time of delivery to lab
- Problems and comments

Example:

A = Cross-sectional area (multiplier) of the well = 0.619 l/ft for 2" well

TD = Total Depth (ft) 101.4
WL = Water Level (ft) 88.2
13.2 ft.

13.2 ft x 0.619 l/ft = 8.2 liters recharge volume

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8. RECORDS

All sampling activities and calibrations will be documented in the field logbook and maintenance log book. Such entries will be as descriptive and detailed as possible, so that a particular situation can be reconstructed.

Field logbooks will be bound with consecutively numbered pages. The sampling supervisor or chemist will assign a number and title to each notebook. (See figures 2 and 3, page 37 and 38.) A logbook is used for the entire quarter, at which time it is turned into the sampling supervisor.

All entries will be made in ink. If an incorrect entry is made, the data will be crossed out with a single strike mark and initialed.

8.1 The following will be logged in the field notebook at each well location.

- Well identification and location
- Date/Time
- Water level device number
- Sampler's names
- Weather conditions
- Equipment
- Calibration standard values

8.3 The following will be logged in the field notebook during purging activities:

- Device used to purge
- Start time/end time for purging
- Water level
- Total depth
- Cross-sectional area of well
- Calculation for well storage volume
- Volume removed
- Was purge water contaminated?
- Water description (e.g., color transitions of purge water, etc.)

3.5 The maintenance log book will include maintenance for all calibrated field parameter instruments, pumps, compressors, bailers, well sounders, etc.

Each entry should include the following:

- Date/time sent for service
- Equipment being serviced
- Personnel doing service
- Summary of maintenance performed
- Parts needed for repair
- Calibration, if performed
- Date/time received back from service

3.6 The Chain of Custody form will be filled out in the field for each sample. It will accompany the sample to the laboratory where it will be relinquished to the laboratory sample receive person (See Figure 1, page 36).

The following entries will be filled out on the Chain of Custody:

- Samplers signatures
- Station No./Well No. (including quality control samples)
- Date/time sampled
- Station location (brief description of location)
- Number of containers
- Types of samples collected (marked by circling or X-out)
- Relinquished signature/Date/Time
- Comments (i.e., well dry, only partial sample, sample bottle broke, etc.)

3.7 The laboratory sample receiving person will log samples into the laboratory system, fill out and distribute parameter worksheets, and tag samples with lab I.D. A detailed procedure for logging in samples is outlined in "Sample Administration - General Laboratory", L-6002.

3.8 Field logbooks, maintenance logbooks, and all laboratory documentation will be kept on file within the General Labs for the current year and the previous year. The four years previous to that will be held in Records Management files on the Rocky Flats Plantsite. All records prior to the previous five years and current year will be sent to permanent storage at a designated location by Records Management.

9. SHUTDOWN

9.1 All equipment used in the field will be locked during storage.

9.2 All log notebooks, maintenance notebooks, Chain of Custody forms, etc. are returned to the laboratory office for storage overnight.

9.3 All samples are delivered to the lab at the end of the day for refrigeration and storage.

9.4 Sample vehicles are to be gassed up at the garage before the shift (7:30-8:30 am) or at the end of shift (2:30-3:30 pm).

9.5 All spent decon solutions and rinse waters from containment wells are to be disposed of in the laboratory process waste.

9.6 Well caps are to be replaced and wells locked before leaving the well area.

9.7 All other disposables, including Tyvex, gloves, rope, and Kimwipes will be disposed of in the laboratory waste dumpster.

10. REFERENCES

10.1 U.S. Environmental Protection Agency. 3rd Edition. November 1986. Test Methods for Evaluating Solid Waste. SW-846.

10.2 U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

10.3 RCRA Part B Permit Application. November 1986. U.S. DOE - Rocky Flats Plant. CO7890010526.

10.4 U.S. Environmental Protection Agency, September. 1986. Technical Enforcement Guidance Document. OSWER 9950.1.

Figure 1

CHAIN-OF-CUSTODY FORM

Proj. # Project Name
-Oct 88 GWMW-
Samplers (Signature):

Well #	Date	Time	Stat. Loc.	No. of Cont. SCAN	VOA	PuAmU	NO3/NO2	METAL	H/3	CSTA	GrA&B	UNFILT
				p2	v	p4	p	g1	g2	p1	p2	p4

Relin. by: Date/Time Received: Relin. by: Date/Time Received:

Relin. by: Date/Time Received: Relin. by: Date/Time Received:

COMMENTS:

CSTA - Chloride, Sulfate, TDS, and Alkalinity
g1 - 1 liter glass
g2 - 250 ml glass amber
p - 125 ml plastic
p1 - 1 liter plastic
p2 - 250 ml plastic
p4 - 4 liter plastic
v - 40 ml voa glass

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FIGURE 2
GROUNDWATER SAMPLING LOG FIELD NOTEBOOK

Well Identification: ____________________ Date: ____________
Well Location: ____________________
Device Number: ____________ Constructed Total Depth: ____________
Water Level Measured: ____________
Measured Total Depth: ____________
1 Volume: ____________

Purge Method: ____________
Start Time: ____________ Stop Time: ____________
Volume Removed: ____________ 3x Volume Calc.: ____________

Was Purge Water Contained? ____________

Purge Water Description:

Sample Method: ____________________ Bailer Number: ____________

FIELD PARAMETER MEASUREMENTS DURING SAMPLING:

Date:	CALIBRATION	TIME 1- :	TIME 2- :	TIME 3- :
Temperature	____	____	____	____
pH	____	____	____	____
Buffers	____			
Calib/Checks	____	____	____	____
Specific Conductance	____	____	____	____
Standard Used	____			
Calib/Checks	____	____	____	____

WATER DESCRIPTION:

Weather Conditions During Sampling: ____________________

Temperature: ____________
Wind Speed: ____________ Precipitation: ____________

VOAS OTHERS

TIME OF DELIVERY TO THE LABORATORY: ______________________________

SAMPLERS NAME(S): ____________ ____________

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FIGURE 3

GROUNDWATER SAMPLING LOG

WELL IDENTIFICATION: ____________________ DATE: ______________

PARAMETER COLLECTED	TIME	PRESERVATIVE	FILTERED
VOA (2)	____	Cool 4°C	N/A
Pu.Am.U	____	HNO_3 pH<2	Yes
NO_3^-	____	H_2SO_4 pH<2	N/A
Metals	____	HNO_3 pH<2	Yes
Sr-90	____	HNO_3 pH<2	Yes
^3H	____	Cool 4°C	N/A
Cl^- and SO_4^{-2}	____	Cool 4°C	N/A
TDS and Alk	____	Cool 4°C	N/A
Gross A and B	____	Cool 4°C	N/A
Cubi =1	____	Cool 4°C	N/A
Cubi =2	____	Cool 4°C	N/A

COMMENTS/PROBLEMS ENCOUNTERED DURING SAMPLING:

____

____

____

____

WELL CONDITION COMMENTS (FOR INSPECTION AND MAINTENANCE):

____

____

____

____

SAMPLING PROCEDURE FOR GROUNDWATER MONITORING PROGRAM   PAGE NO. L-6213-C-38

TABLE 1
GROUNDWATER MONITORING WELLS BY AREA

PLANT BACKGROUND WELLS (9)

10-81	7-82	46-86	47-86	51-86	52-86
53-86	54-86	55-86			

881 HILLSIDE (34)

9-74	10-74	16-74	56-86	57-86	58-86
59-86	61-86	62-86	63-86	64-86	65-86
68-86	69-86	70-86	1-87	2-87	3-87BR
4-87	5-87	6-87	8-87BR	43-87	44-87
45-87BR	47-87	48-87	49-87	50-87	51-87
52-87	53-87	54-87	55-87		

903 PAD (11)

1-71	2-71	9-87BR	10-87	11-87	12-87BR
14-87	15-87	16-87BR	29-87	30-87BR	

MOUND (14)

1-74	33-86	34-86	35-86	36-86	37-86
43-86	17-87	18-87BR	19-87	20-87BR	21-87
22-87BR	23-87BR				

EAST TRENCHES (17)

3-74	39-86	40-86	41-86	42-86	67-86
24-87	35-87BR	26-87	27-87	28-87BR	31-87BR
32-87	33-87	34-87BR	35-87	36-87BR	

SOLAR PONDS AREA (26)

2-60	4-60	13-86	14-86	15-86	16-86
17-86	18-86	19-86	20-86	21-86	22-86
23-86	24-86	25-86	26-86	27-86	28-86
29-86	30-86	31-86	32-86	37-87	38-87
39-87BR					

LANDFILL AREA (22)

6-86	7-86	8-86	9-86	10-86	40-87
41-87	42-87	58-87	59-87	60-87	61-87
62-87	63-87	64-87	65-87	66-87	67-87
68-87	70-87	71-87	72-87		

WEST SPRAY FIELD AREA (10)

8-81	9-81	3-82	5-82	6-82	44-86
45-86	48-86	49-86	50-86		

EAST BUFFER ZONE (10)

1-86	2-86	3-86	4-86	5-86	11-86
12-86	38-86	66-86			

APPENDIX 5.2, Continued

TABLE II
TOTAL CONSTRUCTED WELL DEPTHS

Well	TD (FT)	Well	TD (FT)	Well	TD (FT)
1-86	10.20	24-86	7.45	47-86	94.49
2-86	9.01	25-86	82.00	48-86	207.07
3-86	23-67	26-86	11.00	49-86	67.60
4-86	14.92	27-86	113.00	50-86	96.15
5-86	9.76	28-86	8.60	51-86	79.06
6-86	8.88	29-86	8.77	52-86	125.80
7-86	5.74	30-86	14.93	53-86	7.80
8-86	63.8	31-86	17.32	54-86	85.25
9-86	135.35	32-86	125.50	55-86	36.39
10-86	23.78	33-86	7.34	56-86	9.6
11-86	10.25	34-86	56.25	57-86	6.75
12-86	11.30	35-86	11.60	58-86	3.50
13-86	9.50	36-86	6.50	59-86	28.00
14-86	55.30	37-86	8.55	61-86	18.50
15-86	14.44	38-86	8.50	62-86	35.20
16-86	45.06	39-86	31.5	63-86	15.50
17-86	13.98	40-86	111.50	64-86	9.00
18-86	7.50	41-86	44.70	65-86	8.00
19-86	12.25	42-86	29.70	66-86	6.50
20-86	78.00	43-86	16.75	67-86	14.75
21-86	78.00	44-86	33.00	68-86	3.50
22-86	11.20	45-86	48.20	69-86	14.00
23-86	117.00	46-86	160.79	70-86	7.90

1987

1-87				25-87	43.70
2-87		14-87	32.40	26-87	13.70
3-87		15-87	22.53	27-87	43.25
4-87		16-87	125.24	28-87	197.70
5-87		17-87	25.75	29-87	20.55
6-87		18-87	133.70	30-87	94.35
		19-87	11.89	31-87	129.64
8-87		20-87	116.36	32-87	46.83
9-87	32.40	21-87	10.55	33-87	20.25
10-87	15.30	22-87	88.70	34-87	104.49
11-87	20.50	23-87	37.85	35-87	9.60
12-87	10.25	24-87	13.85	36-87	63.59

LOCATION (Discontinued Wells)

14-74 - 881 Hillside
6-81 - Solar Ponds
4-81 - 881 Hillside
WS-1 - Landfill
7-74 - East Trenches
WS-2 - Landfill
2-81 - East Buffer Zone
1-81 - East Buffer Zone.

SAMPLING PROCEDURE FOR GROUNDWATER MONITORING PROGRAM — PAGE NO. L-6213-C-40

TABLE III

CONTAINMENT WELLS

9-74
43-87

SAMPLING PROCEDURE FOR GROUNDWATER MONITORING PROGRAM

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STANDARD OPERATING PROCEDURE 2.2

FIELD MEASUREMENTS ON GROUND AND SURFACE WATER SAMPLES

1. PURPOSE

To obtain reliable and accurate measurements of the field chemistry of water quality samples.

2. DISCUSSION

For several reasons, taking measurements of water chemistry in the field is preferable to taking measurements in the laboratory. If it is suspected that a particular sample is not representative or valid, resampling and reanalyzing can be immediately performed at the site. In addition, the values of pH, specific conductance, and alkalinity in water chemistry measurements in the field may differ from those in the laboratory. Disadvantages encountered in obtaining field measurements usually relate to the reliability of the particular method and equipment used for the test.

The Remedial Investigation Plan (RIP) contains specific details about the procedures and equipment for this SOP. Refer to the RIP for the type of samples to be collected. Collection and measurement of samples and the documentation of data will be performed as described in the associated procedures.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
2.1	Presample Purging of Wells
2.3	Sampling Monitoring Wells with a Bladder Pump
2.4	Sampling Monitoring Wells with a Bucket-Type Bailer
2.5	Sampling Monitoring Wells with a Submersible Pump
2.6	Sampling Monitoring Wells with a Peristaltic Pump
2.8	Sampling for Volatile Organics

SOP No.	SOP Title
2.9	Surface Water Sampling
3.1	Water Level Measurement
4.3	Monitoring Well Installation

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment. Ensure that there are sufficient quantities of reagents, solutions, and filters.

E. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

F. Contact the carrier that will transport samples to obtain information on regulations and specifications.

G. Consult the site manager about purging techniques, the disposal of purged water and other sampling expendables, and the purchase of standard solutions for electrical conductivity and pH/alkalinity calibrations.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information management codes, location IDs, and sample numbers used in the completion of data forms.

3.2.3. Field

A. Locate the monitoring wells to be sampled and the appropriate decontamination area. Locate the staging area and areas for managing purged water and expendable sampling materials. Check decontamination zones. Plan to purge and sample the wells, moving from the least contaminated well to the well with the highest level of contamination.

B. Assemble the appropriate sampling equipment (tubing, flow-through bath, water quality meters, and other equipment). Check the condition of all supplies and the operation of the equipment.

C. Decontaminate all sampling equipment before taking the first sample and between sampling intervals (see SOP 1.6, General Equipment Decontamination, and the RIP). Rinse pH and conductivity probes with distilled water between measurements. Collect all decontamination solutions and rinsate liquids in a container, drum, or lined pit and dispose of them at the conclusion of the sampling event. If data exist that show that the decontamination and rinsate liquids will not contribute to contamination at the site, they may be disposed of at the site. Rinsate liquids can be disposed of at the well site as long as the disposal area is at least 10 ft from the nearest well.

D. Perform field calibrations for electrical conductivity and pH instrumentation according to manufacturer's specifications for the model of instrument used.

E. Procedures for performing field water quality measurements will be consistent with current Rocky Flats Plant procedures (Appendix 5.2 - SOP 2.1), unless otherwise specified in this SOP.

3.3. Operation

Procedures for measuring the parameters are discussed below. When practical, take final field measurements after at least three bore volumes have been pumped from the well and as close to the time of sampling as possible. Record measurements, instrument readings, calibration runs, and alkalinity determinations on the appropriate forms included in Appendixes 5.2 through 5.5. Complete the forms as described in Appendix 5.6.

3.3.1. Determining pH

A. Connect the probe to the meter.

B. Bring the standard solutions to the temperature of the sample water.

C. Rinse the probe in distilled water and shake completely dry before putting it in a calibrating solution. Avoid rubbing the probe, which may damage the membrane.

D. Standardize the meter immediately before taking the measurement. The calibrating solutions must bracket the sample--either pH 7.0 and pH 4.0 or pH 7.0 and pH 10.0. Use the procedure described below to standardize the meter.

1. Put the probe in the pH 7.0 (or in the pH 4.0 solution if the pH is less than 4.0) and adjust the standardization knob to achieve a reading of 7.0 (or 4.0 for pH less than 4.0).

2. Put the probe in the other solution and adjust the standardization knob to achieve a reading of 4.0 or 10.0, as appropriate.

3. Repeat those two steps until adjustment is no longer required.

E. Clean the probe with distilled water and clean tissues.

F. Put the probe in a beaker containing sample water. Record the measurement within 5 min or after drift has ceased, whichever is sooner.

G. Immediately rinse and air dry the probe and put it in each calibrating solution for about 30 sec. Record the readings.

NOTE: During storage and between measurements, keep the probe immersed in the pH 4.0 solution.

H. Keep hoses leading to the flow-through bath out of direct sunlight because the water can heat up quickly at low discharge rates.

3.3.2. Measuring Temperature

A. Use a Celsius thermometer to measure the temperature in a small Teflon or plastic bucket. Record measurements in the logbook periodically during pumping.

B. Place the bucket close to the wellhead. Keep the bucket and discharge hose away from direct sunlight.

C. Record temperature reading to nearest 0.1 degree Centigrade.

3.3.3. Measuring Electrical Conductivity

A. Calibrate the conductivity meter with at least one standard KCl solution, as outined in the current Rocky Flats Plant procedures (Appendix 5.2 - SOP 2.1). Perform this calibration at least before and after sampling. Keep a record of each calibration and record the temperature of each calibrating solution.

B. Clean the probe and cable with distilled water and clean tissues.

C. Measure conductivity in a Teflon or plastic bottle. Record conductivity periodically (after every two gallons) throughout the time of pumping. Record the position of each setting on the meter.

NOTE: Rinse the probe in distilled water and dry it completely before putting it in a calibration solution.

F. Keep the probe at least two inches away from the cell walls or bucket because most conductivity probes produce an electrical field that may be disturbed if the probe is near a solid object.

3.3.4. Alkalinity Testing

Use a digital titration kit (Hach Kit) to test for alkalinity. Field techniques can be tested by performing alkalinity tests on known solutions prepared by the quality control laboratory. When using the standard solutions, record only the value of alkalinity at a pH of 4.5 on the Standard Alkalinity Record form (Appendix 5.5). The alkalinity of three standard solutions will be determined in triplicate. Perform these tests at the start of field sampling. Report the results to the site manager for confirmation with the known values reported by the laboratory. At the discretion of the site manager, additional standard alkalinity tests may be performed periodically during or after the field sampling period.

Determine the alkalinity of each water sample at the time that the sample is collected; record the results in the appropriate sections of the Groundwater Quality Sampling Record (Appendix 5.3) or Surface Water Quality Sampling Record (Appendix 5.2). Enter alkalinity values for 13 different pH values into the table on the forms and plot the results on the graph. Perform a minimum of two tests on each sample to verify the reproducibility of the values obtained. If possible, have different field personnel run these two tests. If the calculated error is greater than 10%, perform a third test for a redetermination of the error. Three trials are usually sufficient to determine a reasonable field value. At the conclusion of the titration tests, record the pH meter readings in the pH 4.0 and 7.0 buffer solutions. The procedure used to determine alkalinity values is described below.

A. Bring the temperature of the pH 4.0 and 7.0 standard buffer solutions to the temperature of the sample in the flow-through bath. Standardize the meter with the electrode in each of these buffers according to the accepted method. Leave the electrode in the pH 4.0 buffer solution.

B. Rinse the titration flask and the volumetric flask with distilled water, followed by raw sample. Remove droplets of water by vigorous shaking.

C. Measure 100 ml of fresh, unfiltered sample in the volumetric flask and pour it into the titration flask with as little agitation as possible.

D. Rinse the pH electrode, shake it dry, and put it into the titration flask.

E. Record the titrant lot number and date on the water quality data form. Eject a few drops of titrant from the tip of the titrator and wipe the tips with a clean tissue. Reset the counter to 0000.

F. Titrate the solution with acid, gently stirring the solution to ensure mixing. Whenever feasible, use magnetic stirrers. Record pairs of pH and alkalinity readings for the pH values on the data form(s).

G. Rinse all glassware with distilled water.

3.3.5 Dissolved Oxygen Measurement (YSI 1976a)

A. Place meter in intended operating position. Do not move without calibrating.

B. With meter off, adjust meter to zero using center screw.

C. Switch meter to zero and adjust to zero with zero knob.

D. Switch meter to full scale and adjust to "15" on ppm scale using full scale knob.

E. Attach probe to the meter and wait 15 min. to polarize probe.

F. Perform air calibration:

- Switch to calib 02 position;

- Place the probe in moist air (small calibration bottle with a few drops of water) and allow 10 minutes for temperature stabilization (can be same as polarization wait); and

- Set meter to local altitude (6,000 ft amsl) using calib know -- be sure reading is steady.

Calibrate meter against standard solutions (on a weekly basis). Document calibrations in calibration log book.

G. Place probe in sample and stir by raising and lowering the probe about 1 ft per s. Allow probe to equilibrate to sample temperature and dissolved oxygen.

H. Turn switch to temp and read temperature from lower scale.

I. Set 02 solubility factor dial to observed temperature, using the salinity index scale on the dial (salinity determined using SCT meter - each bar on index represents 5,000 ppm chloride concentration).

J. Turn switch to read 02 and read dissolved oxygen value in ppm directly from the meter.

K. Turn off meter, rinse probe with deionized water, add a few drops of deionized water to the sponge in the probe holder, and return probe to holder.

3.3.6 Color and Odor

Record any observation regarding unusual condition of the samples. Especially note color, turbidity, and odor.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to the presampling conditions and fill open sampling holes as specified in the RIP.

C. Make sure all survey or sampling locations are properly staked and the location ID is readily visible on the location stake.

D. Examine electrical conductivity and temperature calibrations (red line location). Adjust data as indicated.

E. Prepare samples and transport according to SOP 1.3, Sample Control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

3.4.2. Documentation

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration) in the logbook.

B. Record the sampling and operating data in the logbook.

C. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages. Draw a slash through sections of pages intentionally left blank.

D. Make any necessary changes on data forms after examining electrical conductivity and temperature calibrations.

E. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

4. SOURCES

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5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Surface Water Quality Sampling Record

5.3. Groundwater Quality Sampling Record

5.4. Data Form Completion

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

Complete all blanks before going to the field.

- ________ Reagents: Alkalinity kit
  - ________ Check reagent volumes
  - ________ Check glass for breakage
- ________ pH meter(s) (circle one)
  - ________ Electrode full of fluid
  - ________ Electrode glass intact
  - ________ Immerse electrode in tap water
  - ________ Calibrate electrode, rinse, fill, and replace cap
  - ________ Temperature probe in tap water
  - ________ Temperature probe in hot water
- ________ Ec Meter
  - ________ Battery: Ok___ Dead___
  - ________ Tap water: Ok___ Faulty___
  - ________ Against calibration solution
  - ________ Solution temp
  - ________ Conductivity of solution
- ________ Hand-held thermometer
  - ________ Temperature in ice water
  - ________ Temperature agrees with lab thermometer
- ________ KCl solutions
- ________ Filters and tubing

APPENDIX 5.1, Concluded

EQUIPMENT AND SUPPLIES CHECKLIST

________ Teflon or plastic bucket

________ Teflon or plastic bottle

________ Titration flask

________ Volumetric flask

APPENDIX 5.2

SURFACE WATER QUALITY SAMPLING RECORD

STATION NO.:

SURFACE WATER QUALITY SAMPLING SHEET

QA Review By/Date:

Location:

Date:

Time:

W.O.#:

Personnel:

Weather:

Sampling Method (describe):

Flow measurements taken?: YES NO

If yes, method: If no, reason:

Sample No.	Filtered Yes, No	Container Type/Volume	Preservative	Parameters	Time Collected

Field Measurements*

D.O.:

Temperature: °C

ph: units

Conductance: umhos/cm

*See field notebook for instrumentation data.

at: °C

APPENDIX 5.3

GROUNDWATER QUALITY SAMPLING RECORD

WELL NO.:________________

GROUND-WATER QUALITY SAMPLING SHEET

QA Review By/Date:________________

Date:________________ Time:________

Location:________________ W.O.#:________

Personnel:________________ Weather:________

Sampling: Evacuation by: Bailing/Pumping/Other:________

Sampling by: Bailing/Pumping/Other:________

Well Diameter:____ in. Depth to Water:____ ft Total Well Depth:____ ft

Volume in Casing:____ gal. Calculation:________

Volume Evacuated before Sampling:____ gal. HNu Reading (Breathing Zone)____ (Background)____ (Headspace)____

Purging Time: Start:____ Finish:____ Date:____

Well Condition Locked? YES/NO Reference Casing: PVC/Steel/SS

Protective Casing: Intact Damaged:________

Concrete: Intact Damaged:________

Comments:________________

Sample No.	Filtered Yes/No	Container Type/Volume	Preservative	Parameters	Time Collected

Field Measurements*	Time	pH	T°	Conductivity @ °T
Initial				
1 Well Bore Volume				
2 Well Bore Volumes				
3 Well Bore Volumes				
4 Well Bore Volumes				
5 Well bore Volumes				

* See Field Notebook for Instrumentation Data

APPENDIX 5.4

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

SURFACE WATER QUALITY SAMPLING RECORD

1. Station No. Designation Station ID Number.

2. QA Review/By/Date. Signature of person completing QA of the form followed by the date the QA was completed.

3. Location. Facility name and specific area within the facility from which the sample was collected.

4. Personnel. Samplers.

5. Date. Date sample was collected.

6. Time. Military time that sampling personnel arrived at location.

7. W.O.#. Work Order or Job Number.

8. Weather. Brief description of weather conditions.

9. Sampling Method. Briefly describe sampling method used for sample collection.

10. Sample No. Sample ID Number.

11. Filtered. Was sample filtered in the field (Y or N).

12. Container. Type of container (glass, plastic, etc.)/volume of container (50 ml, 4l, etc.)

13. Preservative. Sample preservative.

14. Parameters. Analyses requested from laboratory.

15. Time collected. Military time at which sample container was collected.

16. Field measurements. Field water quality readings for Dissolved Oxygen (D.O.), pH, temperature and conductance.

STANDARD OPERATING PROCEDURE 2.3

SAMPLING MONITORING WELLS WITH A BLADDER PUMP

1. PURPOSE

To use a bladder pump to obtain representative groundwater samples at shallow depths that are beyond the capabilities of a peristaltic pump.

2. DISCUSSION

Each site-specific Remedial Investigation Plan (RIP) contains specific details about the procedures and equipment for this SOP. Refer to the RIP for the type of samples to be collected. The collection and measurement of samples and documentation of data will be performed as described in the associated procedures.

For this procedure, a Middleburg squeeze-type bladder pump made completely of stainless steel and Teflon (for example, IEA, TIMCO, Well Wizard, Geoguard, and others) provides the least amount of material interference to the sample (Barcelona 1985). Analyses for a wide variety of metals, radionuclides, and organics, as well as field parameters, are valid for a sample obtained with this system. The water comes into contact with the inside of the bladder (Teflon) and the sample tubing (also Teflon) that may be dedicated to each well. Some wells may have permanently installed bladder pumps (for example, Well Wizard or Geoguard) that will be used to sample for all parameters.

Testing has shown that the non-gas contact positive-displacement pump causes less aeration in the sample than do various other retrieval methods (Barcelona 1984 and Nielsen 1985). Although no system can provide a true *in situ* sample, this method (if employed correctly) can yield a sample that is valid for numerous field measurements and chemical analyses, including organics. Although volatile organics may be collected by this method, sampling for volatile organics is so highly specialized that it is presented separately in SOP 2.8, Sampling for Volatile Organics.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

APPENDIX 5.4, Concluded

GROUNDWATER QUALITY SAMPLING SHEET

1. Well No. Monitoring. Well ID Number.

2. Date. Date sample was collected.

3. QA Review By/Date. Signature of person completing QA of the form followed by the date the QA was completed.

4. Location. Facility name and specific area from which the sample was collected.

5. Personnel. Samplers.

6. Time. Military time that personnel arrived at sampling location.

7. W.O.#. Work Order or Job Number.

8 Weather. Brief description of weather conditions.

9. Sample No. Sample ID Number.

10. Filtered. Was sample filtered in the field (Y or N).

11. Container. Type of sample container (glass, plastic. etc.)/volume of container (ml, l, etc.).

12. Preservative. Sample preservative.

13. Parameters. Analyses requested from laboratory.

14. Time collected. Military time that sample container was collected.

15. Field measurements. Military time and field water quality measurements for pH, temperature and conductivity during presample well purging.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation
1.4	Sample Containers and Preservation
1.5	Guide to Handling, Packaging, and Shipping of Samples
1.6	General Equipment Decontamination
2.1	Presample Purging of Wells
2.2	Field Measurements on Groundwater and Surface Water Samples
3.1	Water Level Measurement

Monitoring wells are sampled immediately after the field measurements are taken by connecting the pump outlet tubing directly to the filter unit for filtered samples. Decrease the pump pressure so that the pressure buildup on the filter does not blow out the pump bladder or rupture the filter. Collect nonfiltered samples directly from the outlet tubing into the sample bottle.

3.2. Preparation

3.2.1. <u>Office</u>

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

F. Contact the carrier that will transport samples to obtain information on regulations and specifications.

G. Ensure that permission to discharge or a containment vessel for purged water has been obtained.

3.2.2. <u>Documentation</u>

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Locate the monitoring wells to be sampled and the appropriate decontamination area. Locate staging area and areas for managing purged water and expendable sampling materials. Check decontamination zones and barricades to public access.

B. Decontaminate all sampling equipment before taking the first sample and between sampling intervals (see SOP 1.6, General Equipment Decontamination, and the RIP).

C. Sample monitoring wells from least to most contaminated to reduce the possibility for cross-contamination.

NOTE: Whenever a sample is collected, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a Water Sample Identification Label affixed to the sample container. SOP 1.3, Sample Control and Documentation, contains copies of the form and label and instructions for completing the form and label.

3.3. Operation

3.3.1. Procedure for Operating a Bladder Pump

A. Unlock the well and use a stiff brush to brush away any dirt or debris from around the well cap, then remove the cap.

B. Determine the presence of any floating organics in the wellbore water column using the method described in SOP 2.1 (3.3C).

C. Lower the precleaned water level probe down the well until the indicator sounds (see SOP 3.1, Water Level Measurement). Measure (to the nearest 0.01 ft) the depth-to-water from the mark on the well casing. Record this measurement in the logbook.

D. For bladder pump purging, proceed as described below.

1. Whenever a well is purged or sampled with the bladder pump, record all field measurements and chemistry determinations on Groundwater Level and the Groundwater Quality Sampling Record form.

   Copies of these forms and instructions for completing the forms are provided in SOP 2.2, Field Measurements on Ground and Surface Water Samples, and SOP 3.1, Water Level Measurement.

2. Purge the well as described in SOP 2.1, Presample Purging of Wells.

3. Attach the pump to the dedicated Teflon tubing. Lower the pump down the well until it is just below the surface of the water. Begin pumping and follow the water level down the wellbore to ensure that all of the stagnant water in the casing is removed. This is not possible for permanently installed dedicated pumps.

4. To avoid pumping the well dry, reduce the pumping rate after the water level has fallen to the screened level so that the rate of water removal does not exceed the rate of recovery after the water level has fallen to the screened level from the formation.

E. Allow the well to recover to the level specified in the Rocky Flats Plant Procedure L-6 213-C for well presample purging before sampling. Use the water level probe to monitor well recovery.

F. The well should be sampled within 24 hours of purging.

3.3.2. Procedure for Collecting Samples

NOTE: Consult the associated SOPs for information about collecting and measuring samples and the documentation of data.

A. Before collecting data, calibrate probes for the required measurements (see SOP 2.2, Field Measurements on Ground and Surface Water Samples).

B. To collect samples. lower the pump down the well until the bottom (intake) of the pump is just at the top of the well screen. The well-dedicated pumps should have been installed at this depth.

C. The type of analysis for which a sample is collected determines the type of bottle, preservative, holding time, and filtering requirements (see SOP 1.4, Sample Containers and Preservation).

D. Adjust the pump and pressure rates with the cycle time so that the flow is not violent. In this way, the sample can be obtained in a timely manner.

E. Do not filter the samples unless so directed by the RIP.

F. Ensure that all samples specified in the RIP have been collected.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to presampling conditions as specified in the RIP.

C. Make sure all monitoring wells are properly labeled and the location I.D. is readily visible on the protective casing.

D. Prepare samples and transport according to SOP 1.3, Sample Control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

3.4.2. Documentation

A. Record cleanup procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

4. SOURCES

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5. APPENDIX

5.1. Equipment and Supplies Checklist

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Nongas contact bladder pump (with Teflon tubing)
- ________ Compressor/batteries/battery chargers
- ________ Amber glass bottles with Teflon-lined caps (0.5, 1, and 2 liters)
- ________ Clear glass vials with Teflon septa (40 ml)
- ________ Plastic bottles (1 liter)
- ________ Teflon or other chemically inert tubing
- ________ Stiff brush
- ________ Concentrated H_2SO_4 (if needed)
- ________ 40% NaOH (if needed)
- ________ Insulated coolers
- ________ Blue Ice or equivalent
- ________ Padding for packaging of samples
- ________ Swagelok fittings
- ________ Plastic sheet
- ________ Any additional supplies listed in associated procedures, as needed

STANDARD OPERATING PROCEDURE 2.4

SAMPLING MONITORING WELLS WITH A BUCKET-TYPE BAILER

1. PURPOSE

To obtain a representative groundwater sample at depths beyond the range (or capability) of suction lift pumps when volatile air stripping is of concern, well-casing diameters are too narrow to accept submersible pumps, or other difficult conditions are present.

2. DISCUSSION

The Remedial Investigation Plan (RIP) contains specific details about the procedures and equipment for this SOP. Refer to the RIP for the type of samples to be collected. Collection and measurement of samples and documentation of data will be performed as established in the associated procedures.

Bucket-type bailers are tall, narrow buckets equipped with a check valve on the bottom. This valve allows water to enter from the bottom as the bailer is lowered and prevents its release as the bailer is raised. Although top-filling bailers are also available and may be useful for well purging, they generally cause increased sample turbulence and are not recommended for sample acquisition.

Because of the aeration associated with most other recovery systems, the bucket-type bailer is the preferred method for collecting samples that are susceptible to volatile component air stripping or degradation. Samples can be recovered with a minimum of aeration if care is taken to gradually lower the bailer until it contacts the water surface and to allow it to sink as it fills. Teflon is generally the best construction material, but other materials (like PVC or stainless steel) are acceptable if compatible with the designated sample analysis outlined in the RIP. The primary disadvantages of bailers are their limited sample volume and inability to collect discrete samples from a depth below the water surface.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activity. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation

SOP No.	SOP Title
1.4	Sample Containers and Preservation
1.5	Guide for Handling, Packaging, and Shipping of Samples
1.6	General Equipment Decontamination
2.1	Presample Purging of Wells
2.2	Field Measurements on Ground and Surface Water Samples
2.8	Sampling for Volatile Organics
3.1	Water Level Measurement

3.2. Preparation

3.2.1. <u>Office</u>

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

F. Contact the carrier that will transport samples to obtain information on regulations and specifications.

G. Ensure that a containment system is available to collect purged water, as appropriate.

3.2.2. <u>Documentation</u>

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Locate the monitoring wells to be sampled and the appropriate decontamination area. Locate staging area and areas for managing purged water and expendable sampling materials. Check decontamination zones and barricades to public access.

B. Decontaminate all sampling equipment before taking the first sample and between sampling intervals (see SOP 1.6, General Equipment Decontamination, and the RIP).

C. Sample monitoring wells from least to most contaminated to reduce the possibility for cross-contamination.

3.3. Operation

3.3.1. Procedures for Operating a Bucket-Type Bailer

A. Unlock the well and use a stiff brush to brush away any dirt or debris from around the well cap, then remove the cap.

B. Determine the presence of any floating organics in the wellbore water column using the method described in SOP 2.1 (3.3C).

C. Lower the precleaned water level probe down the well until the indicator sounds (see SOP 3.1, Water Level Measurement). Measure (to the nearest 0.01 ft) the depth-to-water from the mark on the well casing. Record this measurement in the logbook.

D. Collect a sample from the first bailer if specified in the RIP. Otherwise, purge the well as described in SOP 2.1, Presample Purging of Wells, or SOP 2.3, Sampling Monitoring Wells with a Bladder Pump.

E. Allow the well to recover to the level specified in the current Rocky Flats Plant Procedures for well presample purging before sampling. Use the water level probe to monitor well recovery.

F. Slowly lower the bailer into the well until it contacts the water surface.

G. Allow the bailer to sink and fill with a minimum of surface disturbance.

H. Slowly raise the bailer out of the well. Do not allow the bailer line to contact the ground, either by coiling it on a plastic sheet or by looping it from arm to arm as the line is extracted from the well. The use of a reel greatly simplifies this process.

3.3.2. Procedure for Collecting Samples

NOTE: Also consult the associated SOPs for information on collecting and measuring samples and the documentation of data.

A. Whenever a well is sampled, record all field measurements and chemistry determination on either the Groundwater Level or the Groundwater Levels and Gasoline Thickness Data form, as well as the Groundwater Quality Sampling Record form.

Copies of these forms and instructions for completing the forms are provided in SOP 2.2, Field Measurements on Ground and Surface Water Samples, and SOP 3.1, Water Level Measurement.

B. Tip the bailer to allow a slow discharge to flow gently down the inside wall of the sample bottle with minimal entry turbulence.

C. Filter or preserve the sample as specified in the RIP.

D. Repeat the necessary steps as needed to acquire a sufficient volume of sample (see SOP 1.4, Sample Containers and Preservation).

NOTE: Whenever a sample is collected, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a Water Sample Identification Label affixed to the sample container. SOP 1.3, Sample Control and Documentation, contains copies of the form and label and instructions for completing the form and label.

E. Use a Teflon-lined cap if necessary. Secure the cap tightly.

F. Thoroughly decontaminate the bailer before sampling the next well, according to specific laboratory instructions or the general guidelines in SOP 1.6, General Equipment Decontamination. In some cases, especially where trace analysis is desired, it may be prudent to use a dedicated bailer for each well.

3.4. Postoperation

3.4.1. <u>Field</u>

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to presampling conditions and fill open sampling holes as specified in the RIP.

C. Make sure all monitoring wells are properly labeled and the location ID is readily visible on the protective casing.

D. Prepare samples and transport according to SOP 1.3, Sample Control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

3.4.2. <u>Documentation</u>

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that samples arrived safely and that instructions for sample analyses are clearly understood.

4. SOURCES

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5. APPENDIX

5.1. Equipment and Supplies Checklist

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

_______ Teflon bailers

_______ Amber glass bottles with Teflon-lined caps (0.5, 1, and 2 liters)

_______ Clear glass vials with Teflon septa (40 ml)

_______ Plastic bottles (1 liter)

_______ Stiff brush

_______ Concentrated H_2SO_4 (if needed)

_______ 40% NaOH (if needed)

_______ Insulated coolers

_______ Blue Ice or equivalent

_______ Padding for packaging of samples

_______ Plastic sheet

_______ Any additional supplies listed in associated procedures, as needed

STANDARD OPERATING PROCEDURE 2.8

SAMPLING FOR VOLATILE ORGANICS

1. PURPOSE

To outline procedures for collecting a representative groundwater sample and transporting it from its original environment to the laboratory for analysis of trace volatile organics.

2. DISCUSSION

The growing concern over the detection of volatile organic compounds in water supplies has led to the development of highly sophisticated analytical methods that can provide detection limits at parts-per-billion levels. Although laboratory methods are extremely sensitive, well controlled, and quality assured, they cannot compensate for a poorly collected sample. The collection of a sample should be as sensitive, highly developed, and quality assured as the analytical procedures.

A sample to be analyzed for dissolved volatile organics must be collected with minimal disturbance to limit aeration, which would cause a loss of volatiles from the sample.

Sample retrieval systems suitable for the valid collection of volatile organic samples are bladder pumps and bailers (Barcelona 1984; Bennett 1988; Nielsen 1985). Field conditions and other considerations will limit the choice of system. The focus of concern must be to provide a valid sample for analysis (one that has been subjected to the least amount of turbulence possible).

Materials of construction for bladders, pumps, bailers, and tubing are limited to stainless steel, Teflon, and glass. The tendency of organics to leach into and out of many materials makes the selection of materials critical for these trace analyses. The use of plastics, for example, Tygon, must be avoided. There are numerous ways of introducing foreign contaminants into a sample; these must be avoided by following strict sampling procedures and using only trained personnel.

Holding time for the analysis of volatiles is seven days. It is imperative that the samples are shipped or delivered to the analytical laboratory daily. The bottles must be shipped on their sides to aid in maintaining the airtight seal during shipment, with adequate packing and cooling to ensure that they arrive intact. The sensitivity of the analysis and the fragility of the samples require that all volatile samples are collected in duplicate.

The Remedial Investigation Plan (RIP) contains site-specific details about the procedures and equipment for this SOP. Refer to the RIP for the analyses that are to be performed. Collection and measurement of samples and the documentation of data will be performed as described in the associated procedures.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation
1.4	Sample Containers and Preservation
1.5	Guide to the Handling, Packaging, and Shipping of Samples
1.6	General Equipment Decontamination
2.1	Presample Purging of Wells
2.2	Field Measurement on Ground and Surface Water Samples
2.3	Sampling Monitoring Wells with a Bladder Pump
2.4	Sampling Monitoring Wells with a Bucket-Type Bailer

3.2. Preparation

3.2.1. <u>Office</u>

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

F. Contact the carrier that will transport samples to obtain information on regulations and specifications.

G. Obtain appropriate discharge permits or containment vessels for purged water.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Locate monitoring wells to be sampled and the appropriate decontamination area. Locate the staging area and areas for managing purged water and expendable sampling materials. Check decontamination zones and barricades to public access.

B. Decontaminate all sampling equipment before taking the first sample and between sampling intervals (see SOP 1.6, General Equipment Decontamination, and the RIP). Perform other sampling tasks before collecting the volatile samples (see SOP 2.1, Presample Purging of Wells; SOP 2.2, Field Measurements on Ground and Surface Water Samples; and SOP 2.8, Sampling for Volatile Organics).

C. Sample monitoring wells from least to most contaminated to reduce the possibility for cross-contamination.

3.3. Operation

3.3.1. Preliminary Determinations

A. Floating Organics. If floating organics are of concern (as determined in the RIP and by field measurement for floating organics), obtain the sample with a bucket-type or bottom-valve bailer (see SOP 2.4, Sampling Monitoring Wells with a Bucket-Type Bailer).

B. Purging. Purge the well before sampling, as specified in the RIP and according to SOP 2.1, Presample Purging of Wells. Ensure that the well was not pumped dry and that high flow rates were not employed to cause turbulence in the formation.

C. Field Measurements. As per SOP 2.2 must be made prior to the collection of any laboratory sample.

3.3.2. Sample Retrieval

A. Bladder Pumps. Using a non-gas, contact positive-displacement bladder pump is often mandated when dedicated pumps have been installed on wells. These bladder pumps are also suitable for shallow wells (less than 100 ft). They are somewhat difficult to clean, but can be used with well-dedicated sample tubing to avoid some cleaning. These pumps require a power supply and a compressed gas supply (or compressor). They may be operated at variable flow and pressure rates, which makes them ideal for both purging and sampling.

1. Increase the cycle time and reduce the pressure to the minimum that will allow the sample to come to the surface.

2. Open both vials, set caps in a clean place, and collect the sample during the middle of the cycle. Collecting both samples at the same time provides more similar samples than those collected at different times, but may be difficult. At a minimum, collect two samples from consecutive discharge cycles.

3. Holding the edge of the discharge line at the top edge of the sample vial, allow the water to run down the side into the vial. Do not allow the water to drop or fall into the vial; avoid splashing.

4. Fill the vials just to overflowing. Do <u>not</u> rinse the vials or excessively overflow them. There should be a convex meniscus on the top of the vials.

5. Carefully cap the vials. Place the caps directly over the top and screw down firmly. Do not overtighten and break the cap.

6. Invert the vials and tap gently. Observe vials for at least 10 sec. If an air bubble appears, discard the sample and begin again. It is <u>imperative</u> that no entrapped air is in the sample vial.

7. Immediately place the vials in the protective foam sleeve and place into the cooler. They should be on their sides, rather than straight up.

8. Ship or deliver samples to the laboratory daily. Ensure that the samples are iced, but do not allow them to freeze.

NOTE: Whenever a sample is collected, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a Water Sample Identification Label affixed to the sample container. SOP 1.3, Sample Control and Documentation, contains copies of the form and label and instructions for completing the form and label.

B. Reciprocating Piston-Type, Submersible Pumps. These systems are portable, self-contained, and capable of delivery flow rates of 30 gallons per hour at lifts up to 500 ft. The pump fits into 2-inch wells, which is the most common monitoring well diameter. The flow rate of the pump is varied by increasing or decreasing the driving pressure supplied to the pump from a compressed air container. The gas driving the pump does not contact the sample being purged, making this type of pump the preferred tool to collect samples for volatile organic analyses in deep wells. The samples are collected as described insteps 2-8 of Section 3.3.2.A.

C. Submersible Pumps. These pumps are not as complicated or expensive as the bladder pumps. They provide comparable samples and are often easier to handle and clean than are other pumps. However, they do not have good control of flow rate, and more care must be exercised when sampling with them.

Collect the sample as described in steps 2-8 of Section 3.3.2.A. Use more care with this kind of a pump because the flow rate is not controllable and there is a greater potential for splashing and aeration of the sample.

D. Syringe Samplers. Only a limited number of commercial, syringe-type samplers are available (two are manufactured by IEA and TIMCO). Although some homemade devices apparently provide good, quality samples for volatile analysis, these devices are severely limited in sample volume and are specific to sampling for volatiles. Essentially, they operate with an evacuated chamber that is lowered down the well and allowed to fill from the pressure of the water. The entire mechanism is then brought to the surface with the sample. The sample can then be transferred to a sample vial, or the entire unit may be sent as the sample container.

1. If necessary, evacuate the syringe and lower the sampling device to just below the well screen.

2. Remove the constriction from the device and allow the syringe to fill with sample, applying slight suction.

3. Bring unit to the surface. If necessary, transfer the sample to vials (see steps 2-8 of Section 3.3.2.A).

E. Bailers. Bailers are the most appropriate device for collecting water samples for volatile analysis. Generally, bailers can provide an acceptable sample, provided that the sampling personnel use extra care in the collection process.

1. Securely attach the bailer to a rope or cable.

2. Lower the bailer slowly and gently into the well, until it contacts the water surface, taking care not to shake the casing sides or splash the bailer into the water.

3. Allow the bailer to sink and fill with a minimum of surface disturbance.

4. Retrieve the bailer from the well slowly and gently, avoiding bumping and splashing. Do not allow bailer line to contact the ground either b y coiling it onto a plastic sheet or looping it from arm to arm as the line is extracted from the well.

5. Begin slowly pouring from the bailer; collect the duplicate samples from the midstream sample.

6. Once the bailer reaches the surface, detach the bailer from the cable. Repeat steps 1-5 for the second vial.

7. Proceed as described in steps 2-8 of Section 3.3.2.A.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to presampling conditions as specified in the RIP.

C. Make sure all wells are properly labeled and the location ID is readily visible on the protective casing.

D. Prepare samples and transport according to SOP 1.3, Sample Control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

3.4.2. Documentation

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages. Draw a slash through sections of pages intentionally left blank.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that samples arrived safely and isntructions for sample analyses are clearly understood.

4. SOURCES

Barcelona, M. J., J. A. Helfrich, E. E. Garske, and J. P. Gibb. 1984. "A Laboratory Evaluation of Groundwater Sampling Mechanisms." Groundwater Monitoring Review, Spring 1984: 32-41.

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DOE. 1985. "Field Technical Representaive Manual." 2d ed. U.S. Department of Energy, Uranium Mill Tailings Remedial Action Project Office, Albuquerque Operations Office document, June 1985. Albuquerque, New Mexico.

5. APPENDIX

5.1. Equipment and Supplies Checklist

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Teflon stainless steel bladder pump
- ________ Teflon stainless steel gear-driven submersible pump
- ________ Syringe sampler; stainless steel, Teflon, or glass
- ________ Teflon stainless steel bailer (positive-displacement or point-retrieval)
- ________ Teflon or other chemically inert tubing
- ________ Fittings for pump
- ________ 40-ml amber glass vials; Teflon-lined septa
- ________ Hach field kit for chlorine
- ________ $Na_2S_2O_4$ crystals
- ________ Foam sleeves, coolers, and Blue Ice (or equivalent)
- ________ Cable, reel, and tripod
- ________ Air compressor or bottled nitrogen
- ________ Plastic sheet
- ________ Any additional supplies listed in associated procedures, as needed

STANDARD OPERATING PROCEDURE 2.9

SURFACE WATER SAMPLING

1. PURPOSE

To define guidelines followed by field personnel in sampling surface water bodies and documenting all aspects of surface water sample collection.

2. DISCUSSION

The sampling of streams, rivers, ponds, and lakes requires care to avoid contamination and collect representative samples.

One method for collecting surface water samples uses a peristaltic pump (Korte and Kearl 1984). The pump system allows the union of the filtration assembly with the pump and the sample container. In this method, surface samples are filtered and collected directly with minimal elapsed time. With a peristaltic pump, only inert materials contact the sample. The inert pump tubing is relatively inexpensive and easily replaced.

The preferred method for this sampling is to collect surface water as grab samples. This method involves dipping a beaker, dipper, or other transfer device into the surface water to retrieve samples. The water sample can also be collected directly by dipping the collection bottle into the water and filling, removing, and capping it. This method has several drawbacks, including problems associated with sampling shallow waters like seeps, springs, or shallow streams. The likelihood of extensive air contact during the filtering of a sample and the time lapse before preservatives are added to samples are also problems. The only advantage of the grab-sample method is the low cost.

The Remedial Investigation Plan (RIP) includes guidelines for selecting sampling equipment and analytical methods to be used at each sampling location. The RIP also has specific details about the procedures for this SOP. Collection and measurement of samples and the documentation of data will be performed as described in the associated procedures.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation
1.4	Sample Containers and Preservation
1.5	Guide to the Handling, Packaging, and Shipping of Samples
1.6	General Equipment Decontamination
2.1	Presample Purging of Wells
2.2	Field Measurement on Ground and Surface Water Samples
2.6	Sampling Monitoring Wells with a Peristaltic Pump
2.8	Sampling for Volatile Organics

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

F. Contact the carrier that will transport samples to obtain information on regulations and specifications.

3.2.2. **Documentation**

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for information used in the completion of data forms.

3.2.3. Field

A. Locate sampling sites along the surface water body and the appropriate decontamination area. Check decontamination zones and barricades to public access. If station is new, mark with stakes.

C. Decontaminate all sampling equipment before taking the first sample and between sampling intervals (see SOP 1.6, General Equipment Decontamination, and the RIP).

3.3. Operation

3.3.1. Surface Water Sampling with a Peristaltic Pump

A. Whenever a sample is collected, record all field measurements and chemistry determinations on the Surface Water Quality Sampling Record form. A copy of the form and instructions for completing the form are provided in SOP 2.2, Field Measurements on Ground and Surface Water Samples.

B. Refer to the general discussion about the operation of peristaltic pumps in SOP 2.1, Presample Purging of Wells, and SOP 2.6, Sampling Monitoring Wells with a Peristaltic Pump.

C. To collect a sample, use the procedure outlined below.

1. Attach tubing to peristaltic pump.

2. Lower intake into surface water and begin water removal. Collect or dispose of water in an acceptable container, as specified in the RIP.

3. Record amount of water removed and discharge rates. A calibrated bucket and stopwatch are commonly used for this step.

4. Remove enough surface water through the purge line to ensure that field chemistry parameters are stabilized and to equilibrate the pump and tubing. Refer to SOP 2.2, Field Measurements on Ground and Surface Water Samples.

5. Perform final field measurements (see SOP 2.2, Field Measurements on Ground and Surface Water Samples).

6. Sampling surface water tends to clog filters rapidly. Attach clean filter (if applicable) and prepare to collect raw water samples into empty bottles.

   NOTE: If filtering is required, run a few hundred milliliters (ml) of raw water through the filter before filling the sample bottles.

7. Fill the sample bottle, allowing the sample stream to flow gently down the side of the bottle with minimal entry turbulence. Do not allow dirt or dust to blow into the bottle or bottle cap. Shield bottles or bottle cap, as necessary, to eliminate entry of windblown material.

8. Screw the cap onto bottle tightly and shake the bottle if a preservative (for example, HNO_3, H_2SO_4, or HCl) has been added.

9. Immediately put the samples into an insulated cooler with Blue Ice or the equivalent. For additional instructions, refer to SOP 5.4, Sample Containers and Preservation.

NOTE: Whenever a sample is collected, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a Water Sample Identification Label affixed to the sample container. SOP 1.3, Sample Control and Documentation, contains copies of the form and label and instructions for completing the form and label.

3.3.2. Surface Water Sampling with a Transfer Device

A. Collect grab samples with a transfer device constructed of inert material such as Teflon, stainless steel, or glass. Use the transfer device to transfer liquid from surface waters to a sample bottle. This method prevents unnecessary contamination that would result if the outer surface of the sample bottle were directly immersed in the liquid. In general, field personnel must avoid using metal transfer devices for trace-metal analysis or plastic devices for sampling trace organics.

B. To collect a sample, follow the procedure outlined below.

1. Use the transfer device to fill the sample bottles. Make sure the sample stream flows gently down the sidewall. For samples some distance offshore, an extension device might be required. If so, firmly attach the transfer device to the dipper and tighten all bolts.

2. Record the amount of water removed.

3. Measure field water directly in the surface water body or on sample water in a beaker. (see SOP 2.2, Field Measurements on Ground and Surface Water Samples).

4. Perform steps 5-9 in Section 3.3.1.C (Surface Water Sampling with a Peristaltic Pump).

5. If the sample water is collected directly into the collection bottle, add preservatives after the sample is collected. Rinse the bottle thoroughly and shake it if a preservative (for example, HNO_3, HCL, or H_2SO_4) has been added.

6. Consult the RIP for specific instructions for filtering or preserving the sample in the field. Store the sample immediately according to the proper procedures (see SOP 1.4, Sample Containers and Preservation).

NOTE: Whenever a sample is collected, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a Water Sample Identification Label affixed to the sample container. SOP 1.3, Sample Control and Documentation, contains copies of the form and label and instructions for completing the form and label.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Place a permanent reference (sampling point) marker (for example, a wooden or metal stake with flagging that includes the location and site code) as close to the sampling location as possible.

3.4.2. Documentation

A. Record cleanup procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

4. SOURCES

Berg, E. L. 1982. "Handbook for Sampling and Sample Preservation of Water and Wastewaters." U.S. Environmental Protection Agency report EPA/600/4-82/029, September 1982. Washington, D.C.: U.S. Government Printing Office.

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5. APPENDIX

5.1. Equipment and Supplies Checklist

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

_______ Peristaltic pump

_______ Filtration unit

_______ Teflon bore and fittings

_______ Clean filters and prefilters

_______ Transfer device for grab samples

_______ 2 or 5-gallon carboy container

_______ Wooden stakes

_______ Survey flagging

_______ Plastic or Teflon bucket

_______ Stopwatch

_______ Sample containers and preservatives

_______ Blue Ice or equivalent

_______ Any additional supplies listed in associated procedures, as needed

STANDARD OPERATING PROCEDURE 2.10

STREAM FLOW MEASUREMENT

1. PURPOSE

To define guidelines followed by field personnel for measuring surface water flow rates in ditches, creeks, and springs.

2. DISCUSSION

A flume is an open channel flow-measuring device in which depth of flow is measured to compute flow volume. The Parshall flume is commonly used and is specially configured so as to be easily cleaned. The Cutthroat flume, in contrast to the Parshall, has a flat bottom that allows relatively easy temporary installation in existing channels.

The Subcontractor Site Manager is responsible for selecting flow measurement locations. The Field Team Leader is responsible for measuring flow rates immediately before collecting surface water quality samples in order to prevent contamination.

3. PROCEDURES

Procedures are described below for measuring surface flows by four methods. Existing Parshall and portable Cutthroat flumes are the preferred methods of measurement. Procedures are also presented for the velocity-cross sectional area method and for the bucket and stopwatch method, although these methods are to be used only when the Subcontractor Site Manager determines that the preferred methods are infeasible.

3.1 Associated Procedures

Before every operation, a review of the SOPs 5.1 through 5.10 is necessary. These SOPs contain general information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging and shipping; decontamination procedures/ and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
2.2	Field Measurements on Ground and Surface Water Samples
2.9	Surface Water Sampling
5.1	General Instructions for Field Personnel
5.3	Sample Control and Documentation
5.4	Sample Containers and Preservation

5.5 Guide to the Handling, Packaging and Shipping of Samples

5.6 General Equipment Decontamination

3.2 Preparation

3.2.1 Office

A. Review the SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

E. Obtain a controlled notebook.

F. Ensure the proper operation of all field equipment by using the equipment checklist provided in Appendix F.1.

G. Contact the carrier that will transport samples to obtain information on regulations and specifications.

3.2.2 Field

A. Locate sampling sites along the stream and the appropriate decontamination area. Check decontamination zones and barricades to public access.

B. Decontaminate all sampling equipment before taking the first sample and between sampling intervals (see SOP 5.6, General Equipment Decontamination).

3.3 Operation

3.3.1 Existing Parshall Flumes (Leupold and Stevens 1978)

A. Remove any material that may have been deposited in the flume. Check that flume is level using carpenter's level. Inspect strip chart on recorder to be sure that it is operating. Report any deterioration of the station immediately to the Subcontractor Site Manager.

B. Read the depth of flow on the upstream permanent scale and the downstream permanent scale, if submerged, and record.

C. Measure and record throat width.

D. Record time and data of data collection.

3.3.2 Portable Cutthroat Flume

A. Estimate flow rate and select appropriate throat width for Cutthroat flume.

B. Assemble flume with nuts on outside of flow cross section.

C. Place the flume in the stream bed at the surface water station and level using the carpenter's level. The actual location of the station should be established in the field during the initial measurement event using the following criteria.

1. Channel cross section is small enough that flow can be easily channeled through the flume.

2. Sufficient sediments are available for use in diverting the flow.

3. There is sufficient gradient that free-flowing downstream conditions can be achieved.

D. Use sandbags and local sediments to divert the flow through the flume.

E. Check that there are no backwater effects downstream of the flume. Read the depth of flow from the attached scale and record.

F. Record the throat width.

G. Record the time and date of the measurements.

3.3.3 Velocity - Cross Sectional Area Method (DOI 1977)

A. Mark off a convenient length (10 to 20 feet) along the bank where the width and depth of flow remain relatively constant. Record the marked-off length.

B. Measure and record the width and depth of flow at both the upstream and downstream ends of the marked-off length.

C. Measure and record the time required for a cork to pass through the length.

D. Record the time and date of measurement.

3.3.4 Bucket and Stopwatch Method (DOI 1977)

A. Dam the flow using local sediments so that all of the flow goes through the one-foot length of PVC pipe. Make sure the pipe is high enough off the ground that the flow will enter the selected vessel.

B. Place either the five-gallon bucket of the one-liter beaker under the pipe so that all of the flow is collected. Use the five-gallon bucket for flows in excess of one gallon per minute unless there is insufficient topographic relief to direct the flow into the bucket.

C. Measure the time required to fill the vessel.

D. Record the time and date of the measurement, the time required to fill the vessel, and the volume of the vessel.

3.4 Postoperation

3.4.1 Field

A. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

B. Ensure that all equipment is accounted for, decontaminated (see SOP 5.6, General Equipment Decontamination), and ready for shipment.

C. Restore the site to presampling conditions. Record clean-up procedures in the field logbook.

D. Record any work left uncompleted in the field logbook (like site restoration or long-term monitoring).

E. Place a permanent reference (sampling point) marker (for example, a wooden stake with flagging that includes the location and site code) as close to the measurement locations as possible.

3.4.2 Office

A. Review field forms for completeness. Deliver original forms and logbooks to the site manager for technical review.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCES

Leupold and Stevens, Inc., 1978, Stevens Water Resource Data.

U.S. Department of the Interior, 1977, National Handbook of Recommended Methods for Water-Data Acquisition, revised August 1984.

5. APPENDICES

5.1 Equipment Checklist

5.2 Stream Flow Measurement Data Sheet

APPENDIX 5.1

EQUIPMENT CHECKLIST

_______ Portable Cutthroat flume

_______ Carpenter's level

_______ Tools for assembling flume

_______ Shovel and sandbags

_______ Twenty-foot tape measure graduated to 0.1 feet

_______ Twelve-foot steel tape measure graduated in 0.1 feet

_______ Cork

_______ One foot of PVC pipe

_______ Five-gallon bucket

_______ One-liter beaker

_______ Stopwatch

_______ Pencils

_______ Stream Flow measurement data sheet

_______ Field book

APPENDIX 5.2

STREAM FLOW MEASUREMENT DATA SHEET

STATION NO.: ______________________

STREAM FLOW MEASUREMENT DATA SHEET

QA Review By/Date: ______________________

Location: ______________________ Date: ______________________

______________________ Time: ______________________

Personnel: ______________________ W.O.#: ______________________

____

Measurement Method (Describe): ______________________

____

____

	CALCULATIONS
FOR FLUME MEASUREMENT: o Depth of flow (ft) Upstream Scale: ________ Downstream Scale: ________ o Throat Width (ft): ________ FOR VELOCITY-CROSS SECTIONAL AREA METHOD o Test Section Length (ft): ________ o Test Section Width (ft): Upstream Scale: ________ Downstream Scale: ________ o Test Start Time (min.): ________ o Test Stop Time (min.): ________ FOR BUCKET AND STOP WATCH METHOD o Test Start Time (min.): ________ o Test Stop Time (min.): ________ o Collection Vessel Size: ________ o Volume of Water Collected: ________	

FLOW RATE: ______________________

APPENDIX 5.3

DATA FORM COMPLETION INSTRUCTIONS

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

STREAM FLOW MEASUREMENT DATA SHEET

1. Station No. Designated Station ID Number.
2. QA Review By/Date. Signature of person completing QA of the form followed by the date the QA was completed.
3. Location. Facility name and specific area within the facility from which the sample was collected.
4. Personnel. Crew members.
5. Date. Date measurement was taken.
6. Time. Military time that measurement was obtained.
7. W.O.#. Work order or job number.
8. Measurement Method. Brief description of method used to obtain the stream flow measurement.
9. Fill in appropriate blanks for the measurement method used.
10. Calculations. Space for calculating flow rate.
11. Flow Rate. Calculated flow rate (cfs).

STANDARD OPERATING PROCEDURE 3.1

WATER LEVEL MEASUREMENT

1. PURPOSE

To determine the depth-to-water in an open borehole, cased borehole, monitoring well, or potentiometer.

2. DISCUSSION

The Remedial Investigation Plan (RIP) for the site contains specific details about the procedures, equipment, and frequency of measurements for this SOP. The documentation of water level measurements, air quality for the health and safety of field personnel, and equipment calibration will be performed as described in the associated procedures.

Generally, water level measurements from boreholes, potentiometers, or monitoring wells are used to construct potentiometric surface maps. Therefore, water level measurements at a given site should be collected within a 24-hr period. Under the following conditions, all measurements must be taken within a shorter interval.

- A range of observed changes between wells that is too large to be indicative of natural gradient groundwater
- Drastic atmospheric pressure changes
- Tidally influenced aquifers
- Aquifers affected by river stage, impoundments, or unlined ditches
- Aquifers stressed by intermittent pumping of production wells
- Aquifers being actively recharged because of precipitation event

The device used to measure water levels should be adequate to attain an accuracy of 0.01 ft. Generally acceptable devices are listed below.

- Steel tape
- An electric sounder
- A petroleum product probe
- A transducer

Place a survey mark on the casing as a reference measuring point. The mark should be permanent; a groove cut with a file is recommended. Mark another measuring reference on the grout apron and guard pipe. Document the measuring point in the logbook and on the data form.

Allow water levels in potentiometers and monitoring wells to stabilize for a minimum of 24 hrs after well construction and development before measurements are taken. Recovery may take longer in wells completed in tight formations.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
3.3	Operational Check of Pressure Transducers Used in Measuring Water Levels in Wells
6.1	Health and Safety Monitoring of Combustible Gas Levels
6.2	Health and Safety Monitoring of Organic Vapors with a Photoionization Detector
6.3	Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment. Be sure the water level measuring device has been calibrated.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

E. Record the most recent calibration date for the water level measuring device in the logbook.

3.2.3. Field

A. Locate monitoring wells to be measured and the appropriate decontamination area. Check decontamination zones and barricades to public access.

B. Decontaminate all equipment before taking the first measurement and between measurement intervals (see SOP 1.6, General Equipment Decontamination, and the RIP).

C. When taking a number of water level measurements, it is preferable to start at those wells that are the least contaminated and proceed to those wells that are the most contaminated.

3.3. Operation

A. Whenever a water level is measured, enter a description of the sampling location and record of the measured value onto the Groundwater Level Data (Appendix 5.2) or the Groundwater Levels and Gasoline Thickness Data (Appendix 5.3) form. Use the latter when a petroleum or gasoline product is floating on the static water in the well. Fill out the forms as described in Appendix 5.4, Data Form Completion.

B. Place equipment on a Teflon or plastic sheet.

C. Remove locking well cap. Note the location and date in the logbook and on the appropriate data form.

D. Remove the well casing cap.

E. If required by site-specific conditions, monitor the headspace of the well with a photoionization detector or a flame ionization detector to determine the presence of volatile organic compounds and record the measurements in the logbook or on appropriate forms. For the use of air monitoring instruments, see SOP 6.1, Health and Safety Monitoring of Combustible Gas Levels; SOP 6.2, Health and Safety Monitoring of Organic Vapors with a Photoionization Detector; and SOP 6.3, Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector.

F. Lower an electric, water level measuring device or equivalent (for instance, permanently installed transducers or airline) into the well until the water surface is encountered.

G. Measure the distance from the water surface to the reference measuring point on the well casing and record this distance in the logbook and on the data form in the comments column. If the well casing is damaged, measure from some other permanently fixed structure or the ground surface and note this modification in the logbook and data form.

H. Measure depth-to-water at least twice or until results are reproduced. Record the reproduced measurement in the depth-to-water column on the field form and in the logbook. Record the exact time of the measurement.

I. Remove all downhole equipment; replace the well casing cap and locking steel caps.

J. Rinse all downhole equipment and store for transport to the decontamination area.

K. Note any physical changes (like erosion or cracks) in the protective concrete pad or variation in the total depth of the well in the logbook.

L. If using pressure transducers to measure water levels, refer to SOP 3.3, Operational Check of Pressure Transducers Used in Measuring Water Levels in Wells.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to presampling conditions as specified in the RIP.

C. Make sure the monitoring well is labeled or the borehole is properly staked and the location ID is readily visible on the location stake or protective casing.

3.4.2. Documentation

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies: Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCE

EPA. 1986. "RCRA Groundwater Monitoring Technical Enforcement Guidance Document.: U.S. Environmental Protection Agency unnumbered document. Washington, D.C.: U.S. Government Printing Office.

5. APPENDICES

5.1 Equipment and Supplies Checklist

5.2 Water Level Data Sheet

5.3 Data Form Completion

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Site map showing well locations
- ________ Steel tape and blue surveyor's chalk
- ________ Electric sounder
- ________ Reflection sounder
- ________ Transducer and data logger
- ________ Airline
- ________ Petroleum product detection probe
- ________ Plastic or Teflon sheeting
- ________ Decontamination solutions
- ________ Keys to well locks
- ________ Tape measure graduated in 0.01 ft
- ________ Nonwater-soluble black ink pens

APPENDIX 5.2

WELL NO.: ______________________

WATER LEVEL DATA SHEET

QA Review By/Date: ______________________

LOCATION: ______________________

____

W.O.#: ______________________

COORDINATES:

____

ELEVATION:
Top of Casing: ______________________

Ground Surface: ______________________

STICK-UP:
Total Depth of Well Below
Ground Surface: ______________________

DATE	TIME	MEASURING DEVICE	READING	CONVERSIONS OR CORRECTIONS	---WATER LEVEL--- DEPTH	ELEVATION	BY	COMMENTS

Page: ________ of ________

APPENDIX 5.3

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

WATER LEVEL DATA SHEET

1. Well No. Ground-water monitoring well ID number.

2. QA Review By/Date. Signature of person completing QA of the form followed by the date the QA was completed.

3. Location. Facility name and specific area on the facility property that the well is located.

4. W.O.#. Work order or job number.

5. Coordinates. Surveyed State Plane Coordinates for the well.

6. Elevation.

   Top of Casing. Surveyed elevation of the top of the inner well casing.

   Ground Surface. Surveyed ground surface elevation.

7. Stick-up. Surveyed top of inner well casing minus the surveyed ground surface elevation.

8. Total Depth of Well Below Ground Surface. Well total depth based on well construction records.

9. Measurements.

   A. Date. Date of measurement.

   B. Time. Military time of measurement.

   C. Measurement Device. Device used to obtain measurement.

   D. Reading. Depth to water to the nearest 1/100th foot from the top of the inner well casing.

   E. Conversions or Corrections. Surveyed height of the top of the inner well casing above the surveyed ground surface elevation (stick-up).

F. Water Level.

1. Depth. Depth to water below ground surface (reading minus conversion).

2. Elevation. Ground surface elevation minus depth to water below the surveyed ground surface elevation.

G. By. Initials of person obtaining the measurement.

H. Comments. Record any comments that are relevant to the measurement being acquired (i.e., weather, measured well total depth, casing condition, etc.).

STANDARD OPERATING PROCEDURE 3.2

AQUIFER (SLUG) TESTING

1. PURPOSE

To define field procedures to collect data for the determination of saturated hydraulic conductivity under *in situ* conditions by the slug test method of analysis.

2. DISCUSSION

A slug test measures the artificial fluctuation of the groundwater level in a well over time due to the injection or withdrawal of a volume (slug) beneath the groundwater surface. The primary advantages of using slug tests to estimate conductivities are: (a) estimates can be made *in situ* and errors incurred in the laboratory testing of disturbed samples can be avoided; (b) tests can be performed quickly at relatively low costs because a pumping well and observation wells are not required; and (c) depending on the screened interval, the hydraulic conductivity of small, discrete portions of an aquifer can be estimated (for example, sand layers in a clay). Limitations of slug testing include: (a) only the hydraulic conductivity of the area immediately surrounding the well is estimated, which may not be representative of the average hydraulic conductivity of the area; (b) certain assumptions made in the analysis process; if the assumptions are inappropriate for the geologic conditions at the site, the slug test data are invalid; (c) the storage coefficient, S, usually cannot be determined; and (d) data sufficient for analysis may not be collected if the hydraulic conductivity is relatively high.

The Remedial Investigation Plan (RIP) for the site contains specific details about the procedures and equipment for this SOP. Refer to the RIP for the locations of the wells that are to be tested. Collection, measurement, and documentation of slug tests will be performed as described in the associated procedures.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information on equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

SOP No.	SOP Title
3.1	Water Level Measurement
3.3	Operational Check of Pressure Transducers Used in Measuring Water Levels in Wells

3.2. Preparations

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Contact the carrier that will transport samples to obtain information on regulations and specifications.

F. If data-logging equipment will be used, ensure that it is fully charged and the pressure transducer is functioning.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Locate the monitoring wells to be tested and appropriate decontamination areas.

B. Connect cables and power to the data logger and accessory equipment.

C. Decontaminate the transducer, cable and slug as specified in the Sampling Plan and SOP 1.6, General Equipment Decontamination.

D. Make an initial water level measurement on monitoring wells (see SOP 3.1, Water Level Measurement).

E. Before beginning the slug test, enter the required information into the electronic data logger. The type of information may vary, depending on the model used. When using different models, consult the operator's manual for the proper data-entry sequence to be used. The following example shows data entered into the Enviro-Labs Model DL-120-MCP Data Logger.

1. Baud Rate

2. Station ID

3. Date (YY/MM/DD)

4. Time (HH:MM:SS)

5. Scale Factors for Each Channel

6. Set Transducer Depth

7. Set Logging Sequence

F. Enter the initial water level and transducer design range into the recording device according to the manufacturer's instructions. The transducer design range will be stamped on the side of the transducer. Record the initial water level on the recording device.

3.3. Operation

The following general procedures should be used to collect and report slug test data. The procedures required for a particular slug test may vary slightly from those described, depending on site-specific conditions. Modifications to the test procedures will be contained in the RIP.

The time required for a slug test is a function of the volume of the slug, the hydraulic conductivity of the formation, and the type of well completion. The slug volume should be large enough that a sufficient number of water level measurements can be made before the water level returns to equilibrium conditions. The length of the test may range from less than a minute to several hours.

If the well is to be used as a monitoring well, take precautions so that the contamination does not occur through material introduced into the well. If water is added to the monitoring well, obtain it from an uncontaminated source and transport it in a clean container. Clean bailers or measuring devices before the test. If tests are performed on more than one monitoring well, avoid cross-contamination of the wells.

Conduct slug tests on relatively undisturbed wells. If a test is conducted on a well that has recently been pumped for water-sampling purposes, the measured water level must be within 0.1 ft of the water level before sampling. At least one week should elapse between the drilling of a well and the performance of a slug test.

NOTE: Make an initial water level measurement on monitoring wells before performing the slug test (see SOP 3.1, Water Level Measurement).

3.3.1. Slug Test with Pressure Transducer and Data Logger

Procedures for conducting a slug test with a pressure transducer and data logger are described below.

When the slug test is performed with an electronic data logger and pressure transducer, store all data internally or on computer diskettes or tape. The information will be transferred directly to the main computer and analyzed. Maintain a computer printout of the data in the files as documentation.

A. Determine the static water level in the well, measuring the depth-to-water periodically for several minutes and taking the average of the readings (see SOP 3.1, Water Level Measurement).

B. Cover sharp edges of the well casing with a clean cloth to protect the transducer cables. Tape the cables to the outside of the well casing.

C. Install the transducer and cable in the well below the target drawdown estimated for the test, but at least 2 ft from the bottom of the well. Be sure this depth of submergence is within the design range stamped on the transducer. Temporarily tape the transducer cable to the well to keep the transducer at a constant depth.

D. Connect the transducer cable to the electronic data logger.

E. Slowly lower the slug into the well. The point where the slug contacts the water can be detected by observing the transducer readout. After touching the water, raise the slug slightly above the water.

F. Begin taking data on the electronic logger and lower the slug smoothly to displace and raise the water level. It is important to remove or add the volumes as quickly and smoothly as possible, because the analysis assumes that an instantaneous change in volume is created in the well.

G. Continue measuring and recording depth-time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a plot recovery versus the logorithm of time.

H. Remove the slug and repeat the data collection portions of steps F and G.

3.3.2. Slug Test with Water Level Probe

The procedure for conducting a slug test with a water level probe is described below. If the slug test data are collected and recorded manually, record observations on the Slug Test Data form. A copy of this form is in Appendix 5.2. Fill out the form as described in Appendix 5.3.

A. Determine the static water level in the well, measuring the depth-to-water periodically for several minutes and taking the average of the readings (see SOP 3.1, Water Level Measurements).

NOTE: When measuring water level changes, it is important to take the measurements rapidly for accurate results.

B. Slowly lower the slug into the well. After touching the water, raise the slug slightly.

C. Measure and record the depth-to-water and the time at each reading. The moment when volume is added or removed is Time Zero. Depths should be measured to the nearest 0.01 ft. The number of depth-time measurements necessary to complete the test varies. It is critical to take as many measurements as possible in the early part of the test. Determine the number and intervals between measurements from previous aquifer tests or evaluations.

D. Continue measuring and recording depth-time measurements until the water level returns to equilibrium conditions or a sufficient number of readings have been made to clearly show a trend on a plot recovery versus the logorithm of time.

E. Remove the slug and repeat the data collection portions of steps F and G in Section 3.3.1.

3.4. Postoperation

3.4.1. Field

A. Decontaminate the downhole equipment according to SOP 1.6, General Equipment Decontamination. Cut off contaminated portions of rope and dispose of them.

B. If using an electronic data logger, follow the steps listed below.

1. Stop the logging sequence.
2. Print the data or send to the computer by telephone.
3. Save memory and disconnect the battery at the end of the day's activities.

C. Replace testing equipment in storage containers.

D. Restore the site to testing conditions as specified in the RIP.

E. Make sure all wells are properly labeled and the location ID is readily visible on the protective casing.

3.4.2. Documentation

A. Record cleanup procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Interpret slug test field results with the project hydrogeologist or site manager. Analyze slug test results, using appropriate software packages or graphical solutions.

D. If necessary, send data logger or pressure transducers to the factory for recalibration.

4. SOURCES

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Bouwer, H., and R. C. Rice. 1976. "A Slug Test for Determining the Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." Water Resources Research 12, no. 3.

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5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Slug Test Data Form

5.3. Data Form Completion

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

Water level measuring device:

_______ Water pressure transducers, if appropriate

_______ Electric water level indicator

_______ Weighted tapes with plopper

_______ Steel tape (subdivided into tenths of feet) and blue surveyor's chalk

_______ Electronic data logger (if transducer method is used)

_______ Stainless steel slug of a known volume

_______ Watch or stopwatch with second hand

_______ Tape measure (subdivided into hundredths of feet)

_______ Semilog graph paper (if required) and straight edge

_______ Appropriate references and calculator

_______ Duct tape

_______ Nonwater-soluble black ink pens

APPENDIX 5.2

SLUG TEST DATA FORM

SLUG TEST DATA PAGE ____ OF ____

FACILITY CODE ______________________ **SLUG VOLUME (FT^3)** __________

LOCATION ID ______________________ **LOGGER CODE** __________

LOG DATE ______________________ ACCEPTANCE CODE __________

TEST METHOD: ☐ SLUG INJECTION OR ☐ SLUG WITHDRAWAL

COMMENTS ____

ELAPSED TIME (MIN)	**DEPTH-TO-WATER (FT)**	**ELAPSED TIME (MIN)**	**DEPTH-TO-WATER (FT)**
0.00			

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

COMPLETE BOLDED DATA FOR ENTRY INTO TIME
STD-010 (1/88)

______________________ FORM COMPLETED BY/DATE

______________________ TECHNICAL REVIEWER/DATE

APPENDIX 5.3

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

SLUG TEST DATA FORM

1. Facility code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Location ID. Four-character code assigned sequentially to each borehole, test pit, or surface location where chemical, biological, radiological, and other measurements are taken.

3. Log Date. The date when the measurement was made in the format DD-MMM-YY (01-JAN-88).

4. Slug Volume (Ft^3). Manufacturer's specification for the known volume or displacement of the slug device.

5. Logger Code. Three-character code identifying the company responsible for performing field measurements or collecting samples.

6. Acceptance Code. One-character code assigned by the installation manager.

7. Test Method. The slug device is either injected (dropped) or withdrawn (pulled out) from the monitor well. Check the box that is applicable to the test situation being run.

8. Comments. Any additional information.

9. Elapsed Time (Min). Cumulative time readings from the beginning of the test to the end of the test in minutes.

10. Depth-to-Water (Ft). Depth of water recorded in hundredths of feet.

STANDARD OPERATING PROCEDURE 3.3

OPERATIONAL CHECK OF PRESSURE TRANSDUCERS USED IN MEASURING WATER LEVELS IN WELLS

1. PURPOSE

To describe procedures for conducting office and field checks of pressure transducers.

2. DISCUSSION

The Remedial Investigation Plan (RIP) for the site contains specific details about the frequency of measurements for this SOP. The documentation of water level measurements will be performed as described in the associated procedures. Pressure transducers measure hydrostatic pressure, which can then be converted to groundwater elevations. A transducer measures pressures over a specific range of submergence. Outside this range, measurements will not be accurate. If it is submerged more than two times its design range or subjected to negative pressures, the transducer can be damaged. This SOP describes a method to ensure that the transducer is working properly.

Take several precautions when using transducers of submergence. Vent the transducer cable so that the temperature and barometric pressure will not cause variations in the transducer reading. If the vent port is plugged, inaccurate readings will result. If water enters the vent and flows downward into the transducer, the transducer may be destroyed. The transducer cable is susceptible to physical damage (for example, abrasions on sharp well casings) and chemical degradation from solvents. If the cable is damaged and submerged, the transducer may be destroyed or inaccurate readings may result.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

SOP No.	SOP Title
3.1	Water Level Measurement
3.2	Aquifer (Slug) Testing

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Ensure the proper operation of the electronic data logger and pressure transducer. Review guidelines in the operator's manual for the electronic data logger. Be sure that the data logger or its battery pack is fully charged. Using a three- to four-ft column of water (for example, capped PVC casing), test the response of the electronic data logger and pressure transducer. Conduct a test for the proper depth response and a test for the drift of readings in this column.

<u>Depth Response Test</u>

1. Measure the depth to water using a water level probe.

2. Mark the length of the transducer cable at measured intervals appropriate for the column of water. Using a four-foot column of water, for example, mark the cable with heat-shrink tubing at one-foot intervals (for a three-foot length), or measure cable as lowering it downhole, beginning at the transducer end.

3. Lower the transducer and cable to the bottom of the water column.

4. Connect the cable to the electronic data logger and begin the logging sequence.

5. Wait one minute and raise the transducer a measured length. Wait one more minute.

6. Continue raising the transducer cable to the measured segments and logging the results for one minute until all segments have been measured.

7. Check the lengths recorded on the data logger against the measured lengths and depths measured with a water level probe. If the difference is greater than 2% to 5% of the measured length, return the transducer to the manufacturer for calibration.

<u>Drift Test</u>

1. Measure the depth to water using a water level probe.

2. Lower the transducer into the water column and tape to the edge of the column.

3. Connect the transducer cable to the electronic data logger and begin a fifteen-minute logging sequence.

4. Check the results for noticeable drift of the depth measurement.

5. Check transducer readings against measured depths using a water level probe.

6. Notify the manufacturer if an unacceptable drift is occurring.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms for use during the field water level measurement task (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information management codes and location IDs used in the completion of data forms.

3.2.3. Field

A. Locate the monitoring wells where the pressure transducers will be calibrated and locate the appropriate decontamination areas. Transducers will be calibrated prior to each test.

B. Assemble the testing equipment.

C. Decontaminate the transducer and cable as specified in the Sampling Plan and SOP 1.6, General Equipment Decontamination.

D. Make an initial water level measurement for the calibration monitoring well using a water level sounder according to SOP 3.1, Water Level Measurement.

E. Before beginning the calibration, record the information and enter it into the electronic data logger. The type of information may vary, depending on the model used. When using different models, consult the operator's manual for the proper data entry sequence to be used. The following data are entered into the Enviro-Labs Model DL-120-MCP Data Logger as an example.

   1. Baud rate

   2. Station ID

   3. Date (YY/MM/DD)

4. Time (HH:MM:SS)

5. Scale factors for each channel

6. Set logging sequence (use a logging sequence that will last for at least 3 min).

3.3. **Operation**

A. Cover sharp edges of the well casing with a clean cloth to protect the transducer cables. Tape the cloth-covered cables to the well casing exterior.

B. Repeat the depth response test and drift test described in Section 3.2.1.E.

C. Continue the water level measurement task specified in the RIP (for example, slug test or pumping test).

3.4. **Postoperation**

3.4.1. **Field**

A. After completing the aquifer test, decontaminate the transducer and cable according to SOP 1.6, General Equipment Decontamination. Do not use solvents to decontaminate the transducer cable.

B. Complete the shutdown of the electronic data logger:

C. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

3.4.2. **Documentation**

A. Complete original calibration documentation (data logger printout).

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

3.4.3. **Office**

A. Deliver documentation to the site manager for technical review. He/she will review and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

D. Arrange for the repair of any transducers that were damaged or could not be calibrated.

4. SOURCES

Enviro-Labs, Inc. 1986. "Operation manual: EI-200 Groundwater Monitoring System with Model EL-120-MCP Data Logger," April 1986. Milford, New Hampshire.

In-Situ, Inc. 1984. "Owner's Manual: Hydrologic Analysis System, Model SE200," April 1984. Laramie, Wyoming.

5. APPENDIX

5.1 Equipment and Supplies Checklist

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

________ Electronic data logger

________ Pressure transducer and cable

________ Water level sounder

________ Tape measure graduated in 0.01 ft

________ Capped PVC casing

________ Duct tape

________ Clean water

STANDARD OPERATING PROCEDURE 3.4
AQUIFER PUMPING TEST

1. PURPOSE

To define procedures to conduct pumping tests for the *in situ* determination of the hydraulic properties of water-bearing soils and rocks.

2. DISCUSSION

An aquifer test is a controlled field experiment to determine the hydraulic properties of water-bearing soils and rocks. Groundwater flow varies in space and time and depends on the hydraulic properties of the saturated, porous, or fractured medium and the boundary conditions imposed on the groundwater system. Pumping tests provide results that are more representative of aquifer characteristics than those predicted by slug tests, can be used to determine the hydraulics of interaquifer flow. However, pumping tests require a greater degree of activity and expense than slug tests, and are therefore not always justified for all levels of investigation.

The rationale for the selection of a specific program of aquifer testing is contained in the Remedial Investigation Plan (RIP) for the site. Refer to the RIP for the duration of the pumping test, the location of the observation well, and the data to be collected. Collection of measurements and documentation of data will be performed as described in the associated procedures.

Aquifer characteristics that may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), specific yield (Sy) for unconfined aquifers, and storage coefficient (S) for confined aquifers and the vertical hydraulic conductivity of confining layers. Also, the occurrence and position of recharge or impermeable boundaries can be identified. These parameters can be determined by graphical solutions and computerized programs.

3. PROCEDURES

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

3.1. Associated Procedures

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

SOP No.	SOP Title
3.1	Water Level Measurement
3.3	Operational Check of Pressure Transducers Used in Measuring Water Levels in Wells

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Ensure that permission to discharge is obtained or a containment system is available for collecting water that will be pumped during the test. This is especially important for wells that may produce contaminated water.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Obtain the following information, equipment, and equipment modifications necessary to conduct a pumping test and check the equipment for proper functioning. Obtain assurances from the drilling contractor concerning the completion of the well installation and development and the availability of the necessary equipment to conduct the pumping test. The drilling contractor is responsible for completing the following tasks and supplying the equipment listed below before the arrival of field personnel.

   1. Drilling, installing, completing, and developing all pump wells and one observation well to the proper specifications identified in the RIP.

   2. Installing a submersible or turbine pump. The pumping well should be properly developed before testing.

3. Installing a totalizer meter and an instantaneous flow meter in the discharge line of the pump well to accurately measure and monitor the volume and role of discharge.

4. Installing sufficient pipe to transport the discharge from the pumping well away from the area to prevent infiltration in the pumped zone.

5. Installing a gate valve on the discharge pipe to control the pumping rate.

6. Placing an outlet near the well head, but past the totalizer and flow meters, for water quality determination and sampling.

B. Calibrate all gauges, transducers, flow meters, and other equipment used in conducting pumping tests before use. Obtain copies of the documentation for instrumentation calibration and file them with the records of test data. Calibration records should contain laboratory measurements. If necessary, perform any onsite zero adjustment or calibration. Where possible, check all flow-measurement devices onsite using a container of measured volume and a stopwatch. Verify the accuracy of the meters before testing proceeds.

C. For long-term pumping tests, pretest water levels will be monitored at the test site before performing the test. This can be accomplished by using a continuous recording device like a Stevens Recorder. These records establish the barometric efficiency of the aquifer. The records also help determine if the aquifer is experiencing an increase or decrease in head with time caused by recharge or pumping in the nearby area or diurnal variations. Record changes in barometric pressure during the test (preferably with an onsite barograph) in order to correct water levels for any possible fluctuations that may occur from changing atmospheric conditions. Project the pretest water level trends for the duration of the test. These trends or barometric changes may be used to correct water levels during the test so that they are representative of the hydraulic response of the aquifer from pumping the test well.

D. The duration of the test is determined by the needs of the project and the aquifer properties. In general, longer tests produce more definitive results. A duration of one to several days is desirable, followed by a similar period of monitoring the recovery of the water level. A knowledge of the local hydrogeology and a clear understanding of the overall objectives of the RIP are necessary in determining the duration of the test. The effect of any hydrogeologic boundaries should be considered. There is no need to continue the test if the water level becomes constant with time. This normally indicates that a hydrogeologic source has been intercepted and that additional useful information will not be collected by continued pumping. One simple test for determining the adequacy of data is when the log time compared to drawdown for the most distant observation well begins to plot as a straight line on the semilog graph paper. There are several exceptions to this simple rule of thumb, so it should be considered a minimum criterion.

E. Decontaminate the transducer(s) and cable(s) as specified in the Sampling Plan and SOP 1.6, General Equipment Decontamination.

3.3. Operation

A. The procedure to conduct pumping tests includes monitoring the water level over time in the pumping well and each observation well while the pumping well is discharged at a constant rate.

B. When the pumping test is performed using an electronic data logger and pressure transducer, store all data internally or on computer diskettes or tape. Directly transfer the information to the main computer and analyze it. Maintain a computer printout of the data in the files for documentation. Take manually determined measurements periodically to verify data recorded by the data logger.

C. If an electronic data logger and pressure transducer are not used, record all data on the Pump/Recovery Test Data form (Appendix 5.2). Data collected manually during a logger-transducer pumping test will also be recorded on the form. Fill out the form as described in Appendix 5.3.

Procedures for manual collection of data are as follow.

1. Decontaminate all equipment before beginning test.
2. Measure static water levels in pumping well and observation wells.
3. Lower two-inch piston pump to within approximately one foot of the bottom of the well.
4. Measure the static water level again and commence pumping.
5. Continue pumping at a constant discharge rate for up to eight hours (for tests where observation wells are available) or up to four hours (for single hole tests), or until the rate of drawdown assumes a near constant rate of 0.25 feet of drawdown in one hour.
6. Measure water levels at frequent time intervals with an electric well sounder in the pumping well and nearby observation wells (if available). Water levels shall be measured at 0.5, 1, 1.5, 2.3, 3.5, 10, 20, 30, and 45 minutes, followed by measurements at 1, 1.5, 2, 3, 4, 5, 6, 7, and 9 hours.
7. Measure pumping rates with a five-gallon bucket and watch, or with a flow meter.
8. Record water levels and pumping rates on the drawdown-recovery test data sheets.
9. Calculate water level equivalent to 90% recovery of the static water level.
10. Following pumping, measure water levels in the pumped well and the observation well(s) following the schedule in item 6, until they recover to within 90% of the static water level.
11. Record these data on the drawdown-recovery test data sheets.

12. During the early part of the test, at least one person should be stationed at each observation well and at the pumping well. After the first two hours, two people are usually needed to continue the test. It is not necessary for readings at the wells to be taken simultaneously. It is very important that depth-to-water readings are measured accurately and recorded at the exact time they are measured.

    NOTE: Pressure transducers and electronic data loggers may be used to reduce the field personnel hours required for the pumping test.

D. During a pumping test, measure water levels as often as necessary to produce a meaningful indication of hydraulic properties of the aquifer. Measure water levels as specified in SOP 3.1, Water Level Measurement.

   During the early part of the test, station at least one person at each observation well and at the pumping well. After the first two hours, two people are usually needed to continue the test. It is not necessary for readings at the wells to be taken simultaneously. It is very important that depth-to-water readings are measured accurately and record the exact time the measurement was taken.

   NOTE: Pressure transducers and electronic data loggers may be used to reduce the field personnel hours required for the pumping test.

E. After pumping is concluded, measure recovering water levels to verify the results obtained from the pumping portion of the test. Measure the recovering water levels in the pumping well and the observation wells for a period immediately following the cessation of pumping. Monitoring during recovery should occur for at least half the length of the pumping portion of the aquifer test. The decision to cease monitoring water levels will be based on aquifer recovery.

3.4. Postoperation

3.4.1. <u>Field</u>

A. If using an electronic data logger, follow the steps listed below.

   1. Stop the logging sequence.

   2. Print the data or send it to the computer by telephone.

   3. Save memory and disconnect the battery at the end of the day's activities.

B. Put the testing equipment in storage containers.

C. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

D. Restore the site to pretesting conditions as specified in the RIP.

E. Make sure all wells are properly labeled and the location ID is readily visible on the guard pipe.

3.4.2. Documentation

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Interpret the pumping test results with the project hydrogeologist or site manager. Analyze data using appropriate analytical solution(s).

Analysis Procedures

Data will be analyzed by the Theis method for confined flow-systems (Jacob 1950). Modifications to the Theis equations will be used to analyze data from unconfined systems and to analyze recovery data as discussed below. If drawdown and/or recovery data are available for a nearby observation well, both transmissivity and the storage coefficient of specific yield will be calculated. If only data from the pumped well is available, transmissivity will be calculated and the storage coefficient will be estimated based on laboratory effective porosity tests.

The Theis equation is of the form

$$s = \frac{114.6Q}{T} W(u),$$

where

$$u = \frac{1.87r^2S}{4Tt} \text{ and}$$

$$W(u) = -0.5772 - \text{In}(u) + u - \frac{u^2}{2x2!} + \frac{u^3}{3x3!} \ldots,$$

and where

s = drawdown in feet at an observation well due to pumpage from a given well,

Q = pumpage from the pumping well in gallons per minute,
S = storage coefficient, dimensionless,
T = transmissivity in gallons per day per foot,
r = radian distance in feet from the pumping well to the observation well, and
t = time in days (Freeze and Cherry 1979).

The following limiting assumptions apply to the Theis equation: transmissivity of the porous media is constant in time and space, the porous media is isotropic and homogeneous with respect to transmissivity, the media is infinite in areal extent, there is no leakage from overlying or underlying units, there is only a single pumping well, the pumping rate is constant with time, and wells penetrate the entire thickness of the porous media (Freeze and Cherry, 1979).

For unconfined groundwater flow systems, specific yield (Sy) is used in place of storage coefficient (S), and transmissivity is defined as

$$T = Kb,$$

where

K = hydraulic conductivity in gallons per day per foot squared, and

b = the initial saturated thickness.

Jacob (1950) has shown that this approach is acceptable as long as drawdowns are small compared to the saturated thickness.

To calculate transmissivity and storage coefficient (or specific yield) from recovery data, the Theis equations will be used in the form

$$s = \frac{114.6Q}{T} [W(u_1) - W(u_2)],$$

where

$$u_1 = \frac{r^2S}{4Tt} \text{ and}$$

$$u_2 = \frac{r^2S}{4Tt'} \text{ and}$$

and where
t = time in days since the start of pumping, and
t' = time in days since recovery began (Freeze and Cherry 1979)

D. If necessary, send data logger or pressure transducers to the factory for recalibration.

4. SOURCES

Boulton, N. S. 1954. "The Drawdown of the Water-Table under Non-Steady Conditions Near a Pumped Well in an Unconfined Formation." Proceedings of the Institution of Civil Engineers 3, paper 5979: 564.

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Bouwer, H. 1978. Groundwater Hydrology. New York: McGraw-Hill Book Company.

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Freeze, R. Allen, and John A. Cherry. 1979. Groundwater. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Pump/Recovery Test Data Form

5.3. Data Form Completion

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

Water level measuring device:

________ Water pressure transducer

________ Electric water level indicator

________ Weighted tapes with plopper

________ Steel tape (subdivided into tenths of feet)

________ Electronic data logger (if transducer method is used)

________ Tape measure (subdivided into hundredths of feet)

________ Watch or stopwatch with second hand

________ Semilog graph paper (if required)

________ Waterproof ink pen

________ Thermometer

________ Appropriate references and calculator

________ Barometer or recording barograph (for tests conducted in confined aquifers)

APPENDIX 5.2

PUMP/RECOVERY TEST DATA FORM

PUMP/RECOVERY TEST DATA

PAGE 1 OF ____

FACILITY CODE ____________
DISTANCE FROM PUMPED WELL (FT) ____________
LOCATION ID ____________
LOGGER CODE ____________
LOG DATE ____________
ACCEPTANCE CODE ____________

TEST START:
DATE ____________
TIME ____________
STATIC WATER LEVEL (FT) ____________

TEST END:
DATE ____________
TIME ____________
STATIC WATER LEVEL (FT) ____________

AVERAGE PUMPING RATE (GAL/MIN) ____________
MEASUREMENT METHODS ____________
COMMENTS ____________

PUMP TEST			RECOVERY TEST	
ELAPSED TIME (MIN)	**DEPTH-TO-WATER (FT)**	PUMPING RATE (GAL/MIN)	**ELAPSED TIME (MIN)**	**DEPTH-TO-WATER (FT)**
0.00			0.00	

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

COMPLETE BOLDED DATA FOR ENTRY INTO TIMS

PTD-011 (1/88)

FORM COMPLETED BY/DATE

TECHNICAL REVIEWER/DATE

APPENDIX 5.3

DATA FORM COMPLETION INSTRUCTIONS

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

PUMP/RECOVERY TEST DATA FORM

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Location ID. Four-character code assigned sequentially to each borehole, test pit, or surface location where chemical, biological, radiological, and other measurements are taken.

3. Log Date. The date when the measurement was made in the format DD-MMM-YY (01-JAN-88).

4. Distance From Pumped Well (Ft). Distance the observation well is from the pumping well in feet and tenths of feet.

5. Logger Code. Three-character code identifying the company responsible for performing field measurements or collecting samples.

6. Acceptance Code. One-character code assigned by the installation manager, but entered on the form by field personnel.

7. Test Start Date. The date when pumping was initiated in the format DD-MMM-YY (01-JAN-88).

8. Test Start Time. The time when pumping was initiated using the 24-hr clock with the format of hours:minutes (08:37 for 8:37 a.m. and 19:12 for 7:12 p.m.).

9. Static Water Level (Ft). Depth-to-water in feet and hundredths of feet in the observation well at the beginning of the pumping test.

10. Test End Date. The date when pumping ceased.

11. Test End Time. The time when pumping ceased.

12. Water Level (Ft). Depth-to-water in feet and hundredths of feet in the observation well at the end of the pumping test.

13. Average Pumping Rate (Gal/Min). Total volume pumped (from totalizer meter) divided by the total elapsed time.

14. Measurement Methods. Type of instrument used to measure depth-to-water (may include steel tape, electric sounding probes, Stevens recorders, or pressure transducers).

15. Comments. Any additional information.

PUMP TEST:

a. Elapsed Time (Min.). Time of measurement recorded continuously from time 0.00 (start of test) in minutes.

b. Depth-to-Water (Ft). Depth-to-water in feet and hundredths of feet in the pump or observation well at the time of the water level measurement.

c. Pumping Rate (Gal/Min). Flow rate in gallons per minute of pumping measured from the in-line flow meter. This column should be completed only for the form used with the pumped well.

RECOVERY TEST:

a. Elapsed Time (Min). See above PUMP TEST a.

b. Depth-to-Water (Ft). See above PUMP TEST b.

STANDARD OPERATING PROCEDURE 3.5

PACKER TESTING

1. PURPOSE

To provide information for executing and analyzing packer tests.

2. DISCUSSION

Packer tests are performed in cored sections of open boreholes to isolate and test the hydraulic conductivity of selected zones. The selected zone is sealed with packers and water is injected into the formation under constant pressure. The flow rate and water pressure in the test section is then compared to the hydraulic conductivity of the material (DOI 1980).

A packer is a pneumatically inflatable rubber gland which is used to seal a section of the borehole against leakage so that water pressure can be applied to the test section. Paired "straddle" packers will be used to isolate test zones (U.S. DOI 1980).

The Subcontractor Site Manager is responsible for determining the borehole intervals to be tested. The test intervals will be approved by the Rockwell International CEARP Manager prior to the packer tests.

The Field Team Leader is responsible for supervising packer tests, recording all data, and analyzing data.

The Driller is responsible for performing packer tests.

3. PROCEDURES

3.1 Associated Procedures

Before every operation, a review of the SOPs 5.1-5.10 is necessary. These SOPs contain general information on the performance of field activities. They should be consulted for specific information on equipment and supplies; sample collecting, preservation, packaging, and shipping; decontamination procedures and documentation requirements. Associated SOPs are listed below.

SOP No.	SOP Title
1.1	Borehole Logging and Sampling
3.1	Water Level Measurement
4.1	Drilling and Sampling
5.1	General Instructions for Field Personnel

3.2 Preparation

3.2.1. Office

A. Obtain a sufficient number of the appropriate data collection forms.

B. Review the SOPs listed in Section 3.1.

C. Coordinate schedules/actions with the installation staff.

D. Obtain appropriate permission for property access.

E. Obtain a controlled notebook.

F. Ensure the proper operation of all field equipment.

3.2.2. Field

A. Decontaminate all equipment before performing the first test (see SOP 5.6, General Equipment Decontamination).

B. Record all pertinent information (date, site, ID number, and location) in the field notebook and field form. Note field conditions, unusual circumstances, and weather conditions.

3.3. Procedures (DOI 1980)

A. Test Procedures

1. Record background information at the top of the packer test data sheet.

2. Remove the core barrel and other tools from the hole.

3. Set the packers at the prescribed depth and inflate to at least 70 psi above hydrostatic pressure.

4. Calculation for Pressure gauge determination

Injection pressure = Pinj
Pressure (water column) = Pwc
Pressure (gauge ht) = Pgh
Pressure (overburden) = Povb
Pressure (gauge) = Pg
Pwc = [depth to top of test interval (ft)] (0.43 Psi/ft)
Pgh = (height of gauge above borehole)(0.43 Psi/ft)

For 1/3 Pressure Test:

Pinj 1/3 = [depth to top of test interval (ft)](1 Psi/ft)(1/3)

Pinj 1/3 = Pwc + Pg + Pgh

Calculate Pinj 1/3, Pwc and Pgh
Solve for Pg

So, Pg = Pinj 1/3 - Pwc - Pgh

For 2/3 Pressure Test:

Pinj 2/3 = [depth to top of test interval (ft)](1 Psi/ft)(2/3)

Pinj 2/3 = Pwc + Pg + Pgh

Calculate Pinj 2/3, Pwc and Pgh
Solve for Pg

So, Pg = Pinj 2/3 - Pwc - Pgh

5. Fill the test section with water and adjust the water pressure so the combined static plus gauge pressure does not exceed approximately one-third of the overburden pressure at the top of the test section. Use an overburden pressure of 1 psi/ft.

6. Observe any leaks in the packer assembly or the packer seal and reseat the assembly as necessary.

7. Record the flow rate of water into the hole in gallons per minute at equal intervals until steady readings are achieved (at least 15 minutes).

8. Repeat the test twice more in the same test interval, first at a combined pressure head of approximately two-thirds the overburden pressure, and then again at a combined pressure head of approximately one-third the overburden pressure. The same data recording and time intervals described above should be used.

B. Data Analyses Procedures

Data analyses will be performed by the Field Team Leader as the tests are preformed to assure reasonable results. Calculations will be verified in the office.

The formula for calculating hydraulic conductivity from packer test data is

$$K = \frac{Q}{2(PI)(L)(H)} \ln\left(\frac{L}{r}\right),$$

where

K = Hydraulic conductivity (ft/min),
Q = Injection rate ($feet^3$/min),
L = Length of test section (ft),
H = Differential head of water (ft),
= Distance from the water table to the gauge plus gauge pressure for test intervals below the water table,
= Distance from the center of the test interval to the gauge plus gauge pressure for test intervals above the water table,
r = Radius of borehole (ft),
ln = Natural logarithm, and
PI = 3.141592.

3.4. Postoperation

3.4.1. Field

A. Complete logbook entries, verify the accuracy of entries, and sign/initial, number, and date all pages.

B. Ensure all equipment is accounted for, decontaminated (see SOP 5.6, General Equipment Decontamination).

C. Restore site to presampling conditions.

3.4.2. Office

A. Review field forms for completeness. Deliver original forms and logbooks to site manager for technical review.

B. Perform Packer test analyses by inputting data to Packer test program

4. SOURCES

Department of the Interior, Bureau of Reclamation. 1974. Earth Manual - A Water Resources Technical Publication, U.S. Government Printing Office, 810 p.

5. APPENDICES

5.1 Equipment Checklist

5.2 Packer Test Data Form

APPENDIX 5.1

EQUIPMENT CHECKLIST

________ Organic free water supply

________ Packer assembly

________ Pressure gauge assembly

________ Flow metering device

________ Nitrogen supply and associated connections

________ Watch

________ Lithologic log of borehole being measured

________ Packer test data sheets

________ Field notebook

APPENDIX 5.2

PACKER TEST DATA SHEET

PACKER TEST DATA SHEET

Job No.: ______________________

Location: ______________________

Well No.: ______________________

Borehole Diameter: ______________________

Acrylic Tube Diameter: ______________________

Static Water Level: __________

Date of Water Level: __________

Page ____ of ____

Comments: ______________________

Test Interval No.	Top of Test Interval	Bottom of Test Interval	Test Length (minutes)	Gage Pressure	Gage Height	Avg. H_2O Height	Gage Height +Avg. H_2O Height	Δh	Date of Test	Lithology	Geologist

APPENDIX 5.3

DATA FORMS COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

PACKER TEST DATA SHEET

1. Job No. Work order or job number.

2. Location. Facility name and specific area within the facility that the well is located.

3. Well No. Monitoring well ID number.

4. Borehole Diameter. Diameter (in feet to the nearest 1/100th foot) of the borehole to be tested.

5. Acrylic Tube Diameter. Diameter (in feet) to the nearest 1/100th foot) of the injection tube.

6. Static Water Level. Depth to water below the surveyed ground surface elevation in the monitor well.

7. Date of Water Level. Date that the static water level was measured.

8. Comments. Record any comments relevant to the tests being conducted.

9. Measurements.

   A. Test Interval No. (1 for first interval tested; 2 for second . . . ; etc.).

   B. Top of Test Interval. Depth below ground surface to the top of the interval being tested (feet).

   C. Bottom of Test Interval. Depth below ground surface to the bottom of the interval being testing (feet).

   D. Test Length. Duration of test (minutes).

   E. Gauge Pressure. Pressure reading for each test.

   F. Gauge Height. Height of the gauge above the top of the borehole being tested.

   G. Average H_2O Height. The average height of water in the injection tube for each test.

H. Gauge height and average H_2O height (F and G).

I. Delta H. Change in height of water in the injection tube at the initiation of the test to the height of water in the injection tube at the end of the test (to the nearest 1/100th foot).

J. Date of Test. Date the test was performed for each interval.

K. Lithology. Formation name and lithology being tested at each interval.

L. Geologist. Initials of geologist supervising and documenting the testing.

STANDARD OPERATING PROCEDURE 4.1

SOIL BORING

1. PURPOSE

To ensure acceptable, consistent soil-boring procedures for all pertinent aspects of hazardous waste investigations.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information about the scope and details of the soil-boring operation, including specifications for drilling techniques. Refer to the RIP for the type, number, and depth intervals at which samples will be collected. Collection and measurement of samples and the documentation of data will be performed as specified in the associated procedures.

To the extent possible, the boring process should not alter the medium that is being investigated. Various methods can be used for soil boring. These include, but are not limited to, hollow-stem augering, cable tool, mud rotary, and air rotary. For most investigations, dry hollow-stem augering or cable tool are the preferred drilling methods. Additional information concerning boring techniques is contained in the SOP 4.2, Rock Boring.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation
1.4	Sample Containers and Preservation
1.5	Guide to Handling, Packaging, and Shipping of Samples
1.6	General Equipment Decontamination
4.2	Rock Boring

SOP No.	SOP Title
4.3	Monitoring Well Installation
5.1	Soil and Rock Borehole Logging and Sampling
6.1	Health and Safety Monitoring of Combustible Gas Levels
6.2	Health and Safety Monitoring of Organic Vapors with a Photoionization Detector
6.3	Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector

3.2. Preparation

3.2.1. <u>Office</u>

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. If samples are to be collected for analyses, notify the laboratory of sample types, the number of samples, and the approximate arrival date. In addition, contact the carrier that will transport samples to obtain information on regulations and specifications.

F. Ensure that boring or well-drilling permits required by state or local authorities have been obtained, as well as procedures for compliance with state or local regulations regarding the submission of well logs and samples.

G. Research the site hydrogeology to estimate the key parameters (for example, anticipate the aquifer depth and thickness and types of contaminants).

3.2.2. <u>Documentation</u>

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Before drilling, decontaminate all downhole drilling and sampling equipment, as well as the back of the drilling rig (as described in SOP 1.6, General Equipment Decontamination).

B. Clear the work site of all brush and minor obstructions.

C. Stake the location of utilities and the proposed boring areas.

NOTE: Ensure that proposed boring areas are not traversed by utility transmission ways.

D. If drilling fluid or grout is required, the source(s) of any water to be used in grouting and well installation must be approved by the site manager before field operations.

3.3. Operation

A. Decontaminate sampling equipment between sampling events (as described in SOP 1.6, General Equipment Decontamination).

B. Inventory all samples as specified in SOP 1.3, Sample Control and Documentation.

C. Handle all samples as specified in SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

D. Soil sampling and borehole logging must conform to SOP 5.1, Soil and Rock Borehole Logging and Sampling.

E. If field screening of samples for organic vapors is required, conduct the survey as described in SOP 6.2, Health and Safety Monitoring of Organic Vapors with a Photoionization Detector, and SOP 6.3, Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector.

F. If the boring is to be completed as a monitoring well, review SOP 4.3, Monitoring Well Installation, for pertinent information.

G. Ensure that the back of the drilling rig is free of any leaking hydraulic lines. Surfaces that may potentially come in contact with the borehole or equipment entering the borehole will not be greased.

H. Conduct work in compliance with all Occupational Safety and Health Administration (OSHA) regulations regarding drilling safety and the detection of underground utilities. If required by safety considerations, staked boring should be moved.

I. For each operating drill rig, designate an individual to be responsible for logging the samples, preparing the boring logs and well sketches, and the well installation of that rig.

J. Log the samples, prepare the boring logs and well sketches, and supervise the well installation.

NOTE: Whenever a sample is collected, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a Soil Sample Identification Label affixed to the sample container. SOP 1.3, Sample Control and Documentation, contains copies of the form and label and instructions for completing the form and label.

K. Do not use dyes, tracers, or other substances or introduce them into borings, wells, lysimeters, grout, backfill, groundwater, or surface water unless specifically required by the contract.

L. If drilling fluids are required, maintain portable recirculation tanks to monitor and document fluid loss. (SOP 5.1, Soil and Rock Borehole Logging and Sampling).

M. If specified, air systems include an air line oil filter that requires frequent replacement to remove all oil residue from the air compressor. Describe the air system manufacturer's name, model number, air pressures used, the frequency of changing the oil filter, and the evaluation of air line filtering in the logbook.

N. Follow the sampling interval and type of sampling equipment specified in the RIP unless directed by the site manager.

O. Record all field measurements and comments on the Borehole Log (Soil) form (see SOP 5.1). Complete all lines on the forms. Use the letter designation NA for not applicable, ND for not done, or UNK for unknown when applicable. If some steps or procedures are not performed as described, state the reason (as is practicable) on the Borehole Log (Soil) form or submit it as an attachment.

P. Maintain a daily detailed driller's report during drilling. Resolve all disputes concerning drilling time, standby time, and work progress at the end of each day. The driller's representative should sign and initial the daily report to indicate concurrence. The report should provide a complete description of the number of feet drilled, the number of hours on the job, any shutdowns because of breakdown, the feet of casing set, and other pertinent data.

Q. Collect, containerize, and store excess soil cuttings, waste materials, and decontamination solutions for proper disposal as described in the Operational Safety Analyses (SOP 1.1, Appendix 5.2).

R. If temporary casing is specified in the RIP, advance the casing to the specified depth. Remove all loose material within the casing before sampling. Advance the casing according to project requirements. Use the type of casing-advance technique that is specified in the RIP. The casing will be of the flush-joint or flush-couple type and of sufficient size to allow for soil sampling, coring, or well installation. All casing sections should be straight and free of any obstructions. If hollow-stem augers are used, equip the bit with a plug device that can be removed at the required sampling depth.

S. The abandonment of any boring should follow any appropriate state regulations and be approved before any casing removal or sealing/backfilling. Seal borings by grouting from the bottom of the boring or well to the ground surface. This can be accomplished by placing a tremie pipe at the bottom of the boring and pumping grout through this pipe until undiluted grout flows from the boring at ground surface. The grout or tremie pipe may be gradually withdrawn, as long as the end of the pipe is at least 10 ft below the grout surface. The grout should consist of a neat cement with 4 lbs of commercial bentonite and approximately 7.5 gallons of water added for every 94-lb bag of cement. After the grout has set (about 72 hrs), the contractor should check the abandoned site for grout settlement. Fill any depression in the grout with the grout mix described above. Methods other than those described here may be implemented as dictated by appropriate state or local agencies. Do not use any grout additives except the 4% bentonite.

T. Safety equipment should be specified by the site health and safety officer. In all cases, the minimum physical protection worn by drilling personnel should include a hard hat, safety glasses, gloves, steel-toed leather boots, and hearing protection.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to presampling conditions and fill open sampling holes as specified in the RIP.

C. Make sure all borehole locations are properly staked and the location ID is readily visible on the location stake.

D. Have the driller approve and initial the report of progress at the end of each operating day.

3.4.2. Documentation

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

D. If required by local or state law, file well-installation reports.

E. After a land survey, verify that the drilling permit describes the site location accurately. If necessary, modify and resubmit the permit.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. If samples have been collected for analysis, contact the laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

D. If drilling wastes were stored, determine the appropriate disposal (based on laboratory analysis) of the soils from the borings.

4. SOURCES

Barcelona, M. J., J. P. Gibb, J. A. Helfrich, and E. E. Garske. 1985. "Practical Guide to Groundwater Sampling." U.S. Environmental Protection Agency report EPA/600/2-85/104. Washington, D.C.: U.S. Government Printing Office.

DOE. 1985. "Field Technical Representative Manual." 2d ed. U.S. Department of Energy, Uranium Mill Tailings Remedial Action Project Office, Albuquerque Operations Office document, June 1985. Albuquerque, New Mexico.

5. APPENDIX

5.1. Equipment and Supplies Checklist

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Sample containers
- ________ Appropriate clothing
- ________ Sprayer with clean water for dust control
- ________ Any applicable licenses and permits
- ________ Camera and film
- ________ Measuring tape
- ________ Plastic sheets
- ________ Any additional supplies listed in associated procedures, as needed

STANDARD OPERATING PROCEDURE 4.2

ROCK BORING

1. PURPOSE

To ensure acceptable, consistent rock boring procedures for all pertinent aspects of hazardous waste investigations.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information about the scope and details of the rock-boring operation, including specifications on drilling techniques to be used at a site. Refer to the RIP for the type, number, and depth intervals at which samples will be collected. Collection and measurement of samples and the documentation of data will be performed as specified in the associated procedures.

Rock boring provides samples for logging, geotechnical analysis, and monitoring well installation. The boring process should not (to the extent practicable) alter the medium that is being investigated. Rock-boring techniques include, but are not limited to, cable tool, rotary, reverse-circulation rotary, and coring.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation
1.4	Sample Containers and Preservation
1.5	Guide to Handling, Packaging, and Shipping of Samples
1.6	General Equipment Decontamination
4.3	Monitoring Well Installation

SOP No.	SOP Title
5.1	Soil and Rock Borehole Logging and Sampling
6.1	Health and Safety Monitoring of Combustible Gas Levels
6.2	Health and Safety Monitoring of Organic Vapors with a Photoionization Detector
6.3	Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. If samples are to be collected for analyses, notify the laboratory of sample types, the number of samples, and the approximate arrival date. In addition, contact the carrier that will transport samples to obtain information on regulations and specifications.

F. Obtain all boring or well-drilling permits required by state or local authorities and informtion required for compliance with state or local regulations regarding the submission of well logs and samples. Obtain utility maps for the site and coordinate boring locations with utility companies.

G. Research the site hydrogeology to estimate the key parameters (for example, anticipated aquifer depth and thickness, types of contaminants, and grain-size distribution).

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Before drilling, decontaminate all downhole drilling and sampling equipment, as well as the back of the drilling rig (as described in SOP 1.6, General Equipment Decontamination).

B. Clear the working areas of brush and minor obstructions.

C. Stake the location of utilities and locations for proposed borings.

NOTE: Ensure that proposed boring areas are not traversed by utility transmission ways.

D. If drilling fluid or grout is required, the source(s) of any water to be used in grouting and well installation must be approved by the site manager before field operations.

3.3. **Operation**

A. Decontaminate sampling equipment between sampling events as described in the SOP 1.6, General Equipment Decontamination.

B. Handle all samples as described in the SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

C. Rock sampling and borehole logging must conform to the specifications defined in the SOP 5.1, Soil and Rock Borehole Logging and Sampling.

D. If field screening of samples for organic vapors is required, conduct it as described in the SOP 6.2, Health and Safety Monitoring of Organic Vapors with a Photoionization Detector, and SOP 6.3, Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector.

E. If the boring is to be completed as a monitoring well, review the SOP 4.3, Monitoring Well Installation, for pertinent information.

F. The back of the drilling rig must be free of any leaking hydraulic lines. Surfaces that may potentially come in contact with the borehole or equipment entering the borehole will not be greased.

G. Conduct work in compliance with Occupational Safety and Health Administration (OSHA) regulations regarding drilling safety and the detection of underground utilities. If required by safety considerations, relocate the borings.

H. For each operating drill rig, designate an individual to be responsible for logging samples, preparing boring logs and well sketches, and the well installation of that rig.

I. Do not use dyes, tracers, or other substances or introduce them into borings, wells, soil moisture (water) samplers, grout, backfill, groundwater, or surface water unless specifically required by the contract.

J. If drilling fluids are required, do not use dug (lined) sumps; portable recirculation tanks are required.

K. Log the samples, prepare the boring logs and well sketches, and supervise the well installation.

NOTE: Whenever a sample is collected, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a Soil Sample Identification Label affixed to the sample container. SOP 1.3, Sample Control and Documentation, contains copies of the form and label and instructions for completing the form and label.

L. If specified, air systems should include an air line oil filter that requires frequent replacement to remove all oil residue from the air compressor. The use of any air system should be fully described in the driller's log and include an equipment description, the manufacturer's name, model name, air pressures used, the frequency of changing the oil filter, and an evaluation of the air line filtering.

M. Follow the sampling interval and type of sampling equipment specified in the RIP unless directed by the site manager.

N. Record all field measurements and comments on the Borehole Log (Rock) form (see SOP 5.1). Complete all lines on the forms. Use the letter designation NA for not applicable, ND for not done, or UNK for unknown when applicable. If some steps or procedures were not performed as described, state the reason (as practicable) on the Borehole Log (Rock) or submit it as an attachment.

O. During drilling, maintain a daily detailed driller's report and have a qualified person submit it if requested by the site manager. The report will provide a complete description of the number of feet drilled, the number of hours on the job, any shutdowns because of breakdown, the feet of casing set, and other pertinent data.

P. If rock coring is specified, follow the procedure described below.

   1. Casing is required for the full depth of the overlying surficial materials in borings when rock is cored.

   2. Advance the casing according to specifications in the RIP. The casing should be of the flush-joint or flush-couple type and of sufficient size to allow for soil sampling, coring, and well installation. All casing sections should be straight and free of any obstructions. If hollow-stem augers are to be used, equip the bit with a plug device that can be removed at the required sampling depth.

   3. Use drill rods for drilling rock that are NW in size to minimize vibration and chattering. Rock core size should be NX, NQ (wire line), or a size specified in the RIP.

4. Use core barrels of the improved double-tube varieties (like the Christensen Series C or D models or the equivalent) that are equipped with a split inner tube.

5. Use five-ft barrels at the discretion of the site manager.

6. Make every effort to use clear water as a drilling fluid. In the event that this is impractical, recirculated water may be used at the discretion of the site manager, as long as a settling tank and filtering system are provided.

7. To minimize core losses in soft, erodable rock, the measures listed below should be required by the supervising field technician.

   a. Restrict drilling to short runs of 2 to 3 ft.

   b. Keep drilling water pressure low (under 150 psi).

   c. Keep feed pressure under 100 psi.

8. The supervising geologist should not permit a full coring run to be drilled if he/she suspects that core was left in the hole on the previous run. If this is believed to have occurred, shorten the next coring run by the length of core believed to have been left in the hole. This is necessary to prevent blocking the core barrel and grinding the core.

9. Upon removal of the core barrel from the drill hole, the driller should remove and open the split inner tube and deliver it to the field technician. If necessary to facilitate accurate logging, wipe off the core while it rests in the inner half.

10. Store rock cores in cardboard or wood core boxes so that their relative position by depth is preserved. Note intervals of lost core in the core sequence. Clearly mark the top of the core sequence. Mark boxes with the boring number, cored interval, and box number in cases of multiple boxes. The weight of each fully loaded box should not exceed 75 lbs. No data should appear on or within the box that is not specified on the Boring Log (Rock).

11. Each box should contain core from only one borehole. If spacers are required to separate intervals of core runs, use wooden blocks that have been clearly marked with the missing interval of core.

Q. If tri-cone rotary drilling is used, record the items below.

   1. Rate of drilling

   2. Percent of drilling fluid recovery

   3. Changes in drilling fluid and water color

   4. Lithologic description

Determine lithologies by using a kitchen screen to separate rock particles from the return waters. Describe the cuttings according to SOP 5.1, Soil and Rock Borehole Logging and Sampling. Place the cuttings on plastic sheets for easier tracking of depth and examination.

R. In the abandonment of any boring, follow any appropriate state regulations and obtain approval before any casing removal or sealing/backfilling. Seal borings by grouting from the bottom of the boring or well to the ground surface. This will be accomplished by placing a tremie pipe at the bottom of the boring and pumping grout through this pipe until undiluted grout flows from the boring at the ground surface. The grout or tremie pipe may be gradually withdrawn, as long as the end of the pipe is at least 10 ft below the grout surface. The grout should consist of a neat cement with 4 lbs of commercial bentonite and approximately 7.5 gallons of water added for every 94-lb bag of cement. After the grout has set (about 72 hrs), the contractor should check the abandoned site for grout settlement. Fill any depression in the grout with the grout mix described above. Methods other than those described here may be implemented as dictated by appropriate state or local agencies. Do not use any grout additives except the 4% bentonite.

S. Safety equipment should be specified by the site and safety officer. In all cases, the minimum physical protection worn by drilling personnel should include a hard hat, safety glasses, gloves, steel-toed boots, and hearing protection.

3.4 . Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to presampling conditions as specified in the RIP.

C. Make sure all borehole locations are properly staked and the location ID is readily visible on the location stake or protective casing.

D. Have the driller approve and initial the report of progress at the end of each operating day.

E. Prepare samples and transport according to SOP 1.3, Sample Control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

3.4.2. Documentation

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

D. If required by local or state law, file well-installation reports.

E. After a land survey, verify that the drilling permit describes the site location accurately. If necessary, modify and resubmit the permit.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. If samples have been collected for analysis, contact the laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

D. If drilling wastes were stored, determine the appropriate disposal (based on laboratory analysis) of the soils from the borings.

4. SOURCES

Barcelona, M. J., J. P. Gibb, J. A. Helfrich, and E. E. Garske. 1985. "Practical Guide to Groundwater Sampling." U.S. Environmental Protection Agency report EPA/600/2-85/104. Washington, D.C.: U.S. Government Printing Office.

DOE. 1985. "Field Technical Representative Manual." 2d ed. U.S. Department of Energy, Uranium Mill Tailings Remedial Action Project Office, Albuquerque Operations Office document, June 1985. Albuquerque, New Mexico.

5. APPENDIX

5.1. Equipment and Supplies Checklist

APPENDIX 5.1.

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Sprayer with clean (potable) water for dust control
- ________ Core boxes
- ________ Wood block or lath
- ________ Measuring tape (tenths)
- ________ Large, black permanent marker
- ________ Strapping tape
- ________ Appropriate clothing
- ________ Sprayer with clean water for dust control
- ________ Any applicable licenses and permits
- ________ Camera and film
- ________ Sample containers
- ________ Plastic sheets
- ________ Any additional supplies listed in associated procedures, as needed

STANDARD OPERATING PROCEDURE 4.3

MONITORING WELL INSTALLATION

1. PURPOSE

To ensure acceptable, consistent monitoring well installation.

2. DISCUSSION

Monitoring well installation creates a permanent access for collecting groundwater samples and measuring aquifer characteristics.

The Remedial Investigation Plan (RIP) provides information about the scope and details of monitoring well installation at a given site. A list of critical issues involved in monitoring well installation are listed below.

- Soil/rock boring technique
- Casing and screen materials
- Casing and screen diameter, screen length, and screen interval
- Filter pack and screen size

The RIP contains specific details about the procedures and equipment for this SOP. Refer to the RIP for the location and specifications of the wells to be installed. Borehole drilling, development of the wells, collection and measurement of samples, and the documentation of data will be performed as described in the associated procedures.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

SOP No.	SOP Title
2.2	Field Measurements on Ground and Surface Water Samples
3.1	Water Level Measurement
4.1	Soil Boring
4.2	Rock Boring
4.4	Monitoring Well Development
5.1	Soil and Rock Borehole Logging and Sampling
6.1	Health and Safety Monitoring of Combustible Gas Levels
6.2	Health and Safety Monitoring of Organic Vapors with a Photoionization Detector
6.3	Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Research site hydrogeology to estimate key parameters (for example, anticipated aquifer depth and thickness, types of contaminants, and grain-size distribution).

E. If water/sand slurry or grout is required, the source(s) of any water used must be approved by the site manager before field operations.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

E. Record all pertinent information (date, site, ID #, and location) in the logbook or on the appropriate form. Include field conditions, unusual circumstances, and weather. Instructions for logbook entries are in SOP 1.3, Sample Control and Documentation.

3.2.3. Field

A. Decontaminate all equipment before monitoring well installation, as specified in SOP 1.6, General Equipment Decontamination.

3.3. Operation

A. Monitor downhole and the breathing zone according to SOP 6.1, Health and Safety Monitoring of Combustible Gas Levels; SOP 6.2, Health and Safety Monitoring of Organic Vapors with a Photoionization Detector; and SOP 6.3, Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector. Perform readings as often as necessary to ensure the safety of workers. Record all measurements on the data collection forms included with these SOPs.

B. Record all field measurements and comments on the Well Completion Information or the Borehole/Well Construction Field Data Log form. Complete all lines on the forms. Use the letter designation NA for not applicable, ND for not done, or UNK for unknown when applicable. If some steps or procedures were not performed as described, state the reason (as practicable) on the form or submit it as an attachment. Copies of these forms are in Appendix 5.1 and Appendix 5.2, respectively. Fill out the forms as described in Appendix 5.6. For a current list of codes used in the data form completion, consult the ER Program data administrator.

C. Upon termination of the borehole, design monitoring well according to specifications set forth in the RIP. Obtain approval for well design from Site Manager before proceeding with well installation.

D. Calculate the amount of well screen, blank casing, filter pack, bentonite, and cement that will be required for well construction. The volume of backfill materials can be calculated using the following formula:

$$h[(pi)\ r^2\ (borehole) - (pi)\ r^2\ (casing\ string)] = ft^3$$

$$ft^3 \times 7.48\ gal/ft^3 = gallons\ of\ material$$

where:

pi = 3.1416

L = length of borehole to be backfilled (in feet) and

r = borehole radius (in feet)

E. Measure the length of the screened interval and the blank casing to the nearest 1/100th foot. Record measurements in logbook.

F. If installing an open borehole, use PVC or stainless steel centralizers to assure the uniform and complete annular filling by granular backfill, seal, and grout materials. Fasten centralizers to the well casing by mechanical fasteners and radially space them around the casing at 120^{o} or 90^{o} intervals. On the Borehole/Well Construction Field Data Log form (Appendix 5.2), provide a description of the fastening device and centralizer that includes their locations.

G. Pull all augers and drill pipe from borehole. If borehole stability is a problem, the well may be completed inside the hollow stem augers or drill pipe.

H. Measure total depth of borehole prior to well installation and record in logbook.

I. Backfill base of borehole to desired total depth with bentonite pellets. Measure borehole total depth prior to installing well string and record in logbook. If the borehole is dry, add one to five gallons of organic-free water to the bentonite pellets. Allow the bentonite to swell for approximately 15 minutes.

J. Place casing string in open borehole (or inside augers or drill pipe if appropriate). Place a slip-on cap over the top of the well string.

K. Measure length of casing above ground surface (stick-up) and compute total depth of well. Make sure this value agrees with well design to the nearest 0.10 ft. If a discrepancy exists, contact Site Manager.

L. If specified, place a sand pack (granular backfill or gravel pack) in the annulus next to the well screen in all monitoring wells.

1. Fill the annulus between the well screen and borehole wall with silica sand.

2. Slowly pour filter pack into borehole annulus making sure it is evenly distributed around the well casing. Measure depth to the top of the filter pack after each bag is added. Make more frequent measurements as filter pack approaches the desired depth.

3. For wells deeper than approximately 50 ft or as determined by the site manager, use a tremie pipe to place the sand pack. If tremie pipe is used, measure all downhole pipe to the nearest 0.10 ft as it is placed in the borehole.

4. Ascertain the depth of the top of the sand, and verify the thickness of the sand pack. If necessary, add more sand to bring the top of the sand pack to the proper elevation. Record final measurement to the nearest 0.01 ft in logbook.

5. Under no circumstances should the sand pack extend into any aquifer other than the one to be monitored. In most cases, the well design can be

modified to allow for a sufficient sand pack without the threat of cross flow between producing zones..

6. In materials that will not maintain an open hole, leave the hollow-stem augers or drill pipe in the hole during sand pack placement to the extent practical. Remove them as the level of the sand pack rises above the bottom of the augers.

M. Place a bentonite seal between the sand pack and grout to prevent infiltration of cement into the filter pack and the well. Place the bentonite seal in the monitoring well as described below.

1. Fill the annulus between the well casing and borehole with a bentonite seal as specified in the RIP in the interval between the sand pack and the grout seal.

2. Use bentonite pellets. Pour the bentonite pellets directly down the annulus. Pour the pellets from different points around the casing to ensure even application. A tremie pipe may be used to redistribute and level out the top of the seal.

3. For the wells deeper than approximately 50 ft, the bentonite may either be poured as pellets or introduced as a slurry. The method should be determined by the site manager after evaluating the condition of the well and borehole wall. If there are no centralizers in the upper portions of the casing, manipulate the casing to prevent pellets from hanging up in the narrow annulus and to allow them to settle to the bottom as rapidly as possible.

4. If a slurry of bentonite is used as annular seal, prepare the slurry by mixing powdered or granular bentonite with potable water. The slurry should be of sufficiently high specific gravity and viscosity to prevent its displacement by the grout that will be placed above. Regardless of depth and depending on fluid viscosity, a few handfuls of bentonite pellets may be dumped in to solidify the surface of the bentonite slurry as a precaution.

5. Before pumping the seal, be sure the sand pack has ceased settling by measuring the depth of the top of the sand with the tremie pipe. The sand pack should provide an adequate cover over the screen.

6. Visually check the condition of the slurry by pumping into a bucket or onto the ground. Retract the tremie pipe 3 ft from the top of the sand pack and begin pumping.

7. In materials that will not maintain an open hole, leave the hollow-stem augers or drill pipe in the hole during bentonite seal placement to the extent practical. Remove them as the level of the bentonite rises above the bottom of the augers.

8. Measure depth to the top of the seal to verify that the proper thickness of seal has been placed in the annulus.

9. Until the specified quantity of bentonite has been placed in the well annulus, repeat the application and verification. Record the final measurement to the nearest 0.01 ft in the logbook for the grout.

10. If the bentonite pellets are above the water table, add one to two gallons of organic-free water to the borehole. Allow the bentonite to swell for approximately 15 minutes before grouting to the surface.

N. Place grout from the top of the bentonite seal to the surface and allow a minimum of 24 hours to set up. Only Type I or Type II cement without accelerator additives may be used. Place grout in the monitoring wells as described below.

1. Mix cement with a ratio of approximately 7.5 gallons of water per 96 pound bag of cement. Up to 4 pounds of bentonite powder may be added to each 96 pound bag of cement if specified in the RIP.

2. If the grout will be placed below the water table or greater than 10 feet below ground surface, tremie pipe will be used.

3. If tremie pipe is used, measure all downhole pipe to the nearest 0.10 ft as it is placed in the borehole.

4. Pump or pour the grout through the tremie pipe (or the open borehole if no tremie pipe is needed) to the bottom of the open annulus until undiluted grout flows from the annulus at the ground surface.

5. In materials that will not maintain an open hole, leave the hollow-stem augers or drill pipe in the hole during grouting to the extent practical. Remove them as the level of the grout rises above the bottom of the augers.

6. While the grout is still green, add more grout to compensate for the removed casing or auger and tremie pipe and to ensure that the top of the grout is at or above the ground surface.

O. Install protective casing around all monitoring wells. Exceptions may be made on a case-by-case basis. The minimum elements in the protection design include those listed below.

1. The protective steel cap should keep precipitation out of the protective casing and should be secured to the protective casing by padlocks.

2. Set a 5-ft (minimum) length of black iron pipe or galvanized pipe so that the top of the pipe is about 1.5 to 3 ft above the ground surface and grout it in place as shown in Appendixes 5.3 and 5.4.

3. Use a pipe diameter of 8 inches for 4-inch wells and 6 inches for 2-inch wells (depending on approved borehole size). A drain hole near ground level that is 0.5 inch in diameter is permitted.

4. Provide a protective steel cap and secure it to the top of each protective casing.

5. Weld the location ID on the protective casing.

P. Place form for concrete surface pad around well casing. Mix concrete and pour surface pad around well casing. Slope pad away from the well with a trowel. Follow specifications in the RIP for concrete pad construction.

Q. In addition to the protective casing, the installation of guard posts is recommended in areas where vehicle traffic might pose a hazard.

Guard posts shown in Appendix 5.5 consist of steel posts that are 3 inches in diameter or tee-bar driven steel posts. Three are radially located 4 ft around each well and driven 2 ft below the ground surface, having a minimum of 4 ft above the ground surface with flagging in areas of high vegetation. Each post may be cemented in place.

R. In the event that a borehole must be abandoned for failure to reach the specified depth (or any other cause), grout the borehole with a tremie pipe from the bottom up with grout mixed to the specifications described in Section 3.3.N.

S. In the event that a well must be abandoned for failure to reach specified depths, loss of tools, or inadvertent contamination, rip the screened interval with an appropriate tool. Grout the well with a tremie pipe (from the bottom up) with grout mixed to the specifications described in Section 3.3.N.

T. Record the diagram of the well installation on the Well Completion Information form and show the depth from surface grade of bottom of the boring, sump, screen location, granular backfill, seals, grout, cave-in, centralizers, and the height of the riser above the ground surface. Record the actual composition of the grout, seals, and granular backfill on each Borehole/Well Construction Field Data Log form. Include the screen slot size (in inches), slot configuration, and screen manufacturer.

3. **Postoperation**

3.4.1. <u>Field</u>

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to predrilling conditions as specified in the RIP.

C. Make sure all monitoring wells are properly labeled and the location ID is readily visible on the protective casing.

3.4.2. Documentation

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCES

Barcelona, M. J., J. P. Gibb, J. A. Helfrich, and E. E. Garske. 1985. "Practical Guide to Groundwater Sampling." U.S. Environmental Protection Agency report EPA/600/2-85/104. Washington, D.C.: U.S. Government Printing Office.

DOE. 1985. "Field Technical Representative Manual." 2d ed. U.S. Department of Energy, Uranium Mill Tailings Remedial Action Project Office, Albuquerque Operations Office document, June 1985. Albuquerque, New Mexico.

Gass, T. E., 1988. "Monitoring Well Filter Pack and Screen Slot Selection." Water Well Journal, June 1988, v. 42, No. 5, pp. 30-32.

5. APPENDICES

5.1. Well Completion Information Form

5.2. Typical Alluvial Monitor Well Construction

5.3. Typical Shallow Bedrock Well Construction (weathered claystone)

5.4. Typical Shallow Bedrock Well Construction (weathered sandstone)

5.5. Typical Bedrock Monitor Well Construction (unweathered sandstone)

5.6. Post Placement Around Well

5.7. Data Form Completion

APPENDIX 5.1

WELL COMPLETION INFORMATION FORM

WELL
COMPLETION
INFORMATION

Location ______________________ Well No. ______________________

Coordinates ______________________ Elevation: Ground Surface ______________________

Total Depth: Well ______________________ Top of Casing ______________________

Borehole ______________________

Formation of Completion ______________________

Casing Material ______________________ Casing Diameter ______________________

Screen Material ______________________ Surface Casing Diameter ______________________

Date Installed ______________________ Approved By ______________________

Site Manager

Installed By ______________________

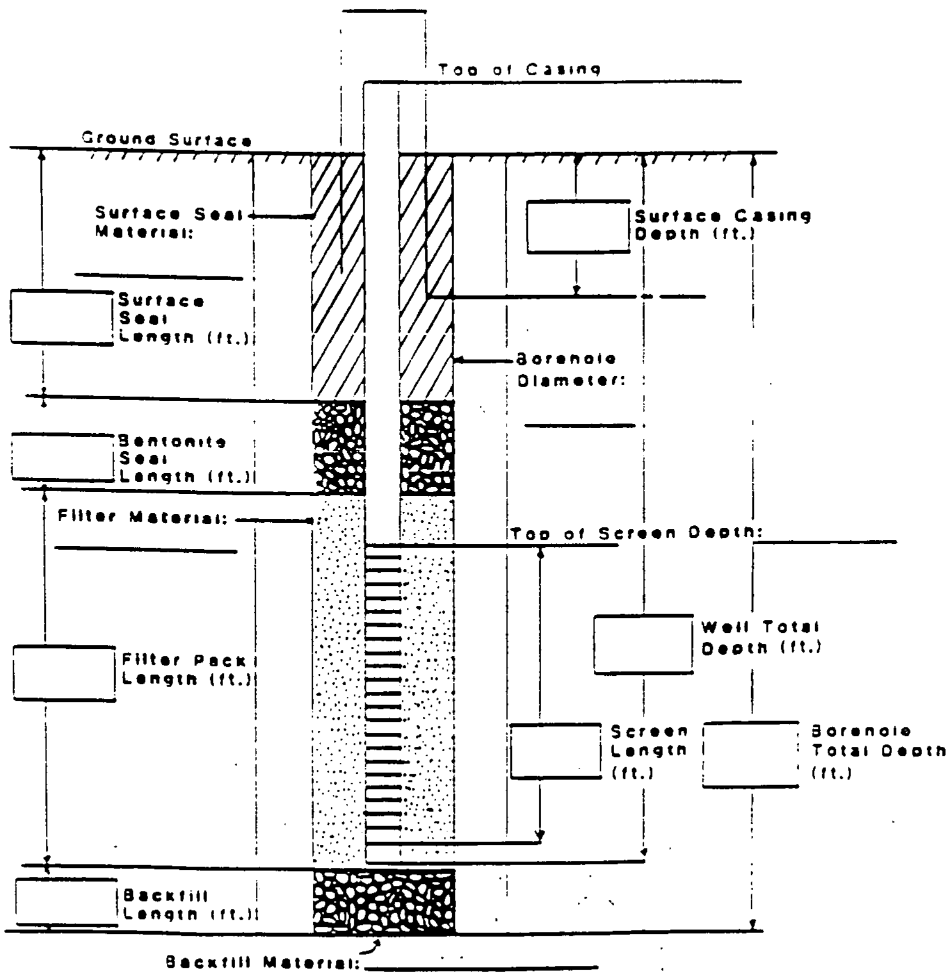
Geologist

____

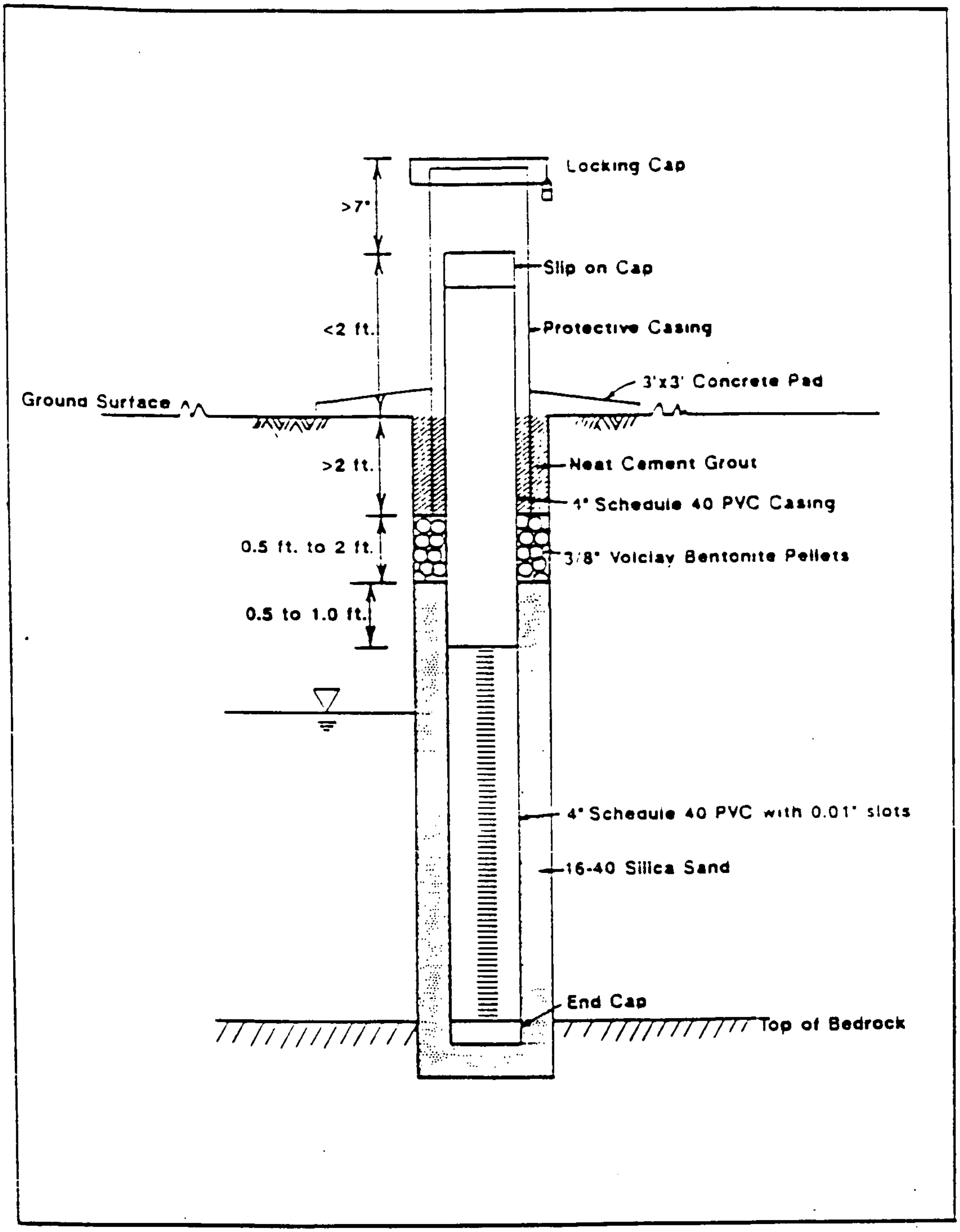
CEARP Manager

Comments ______________________

____



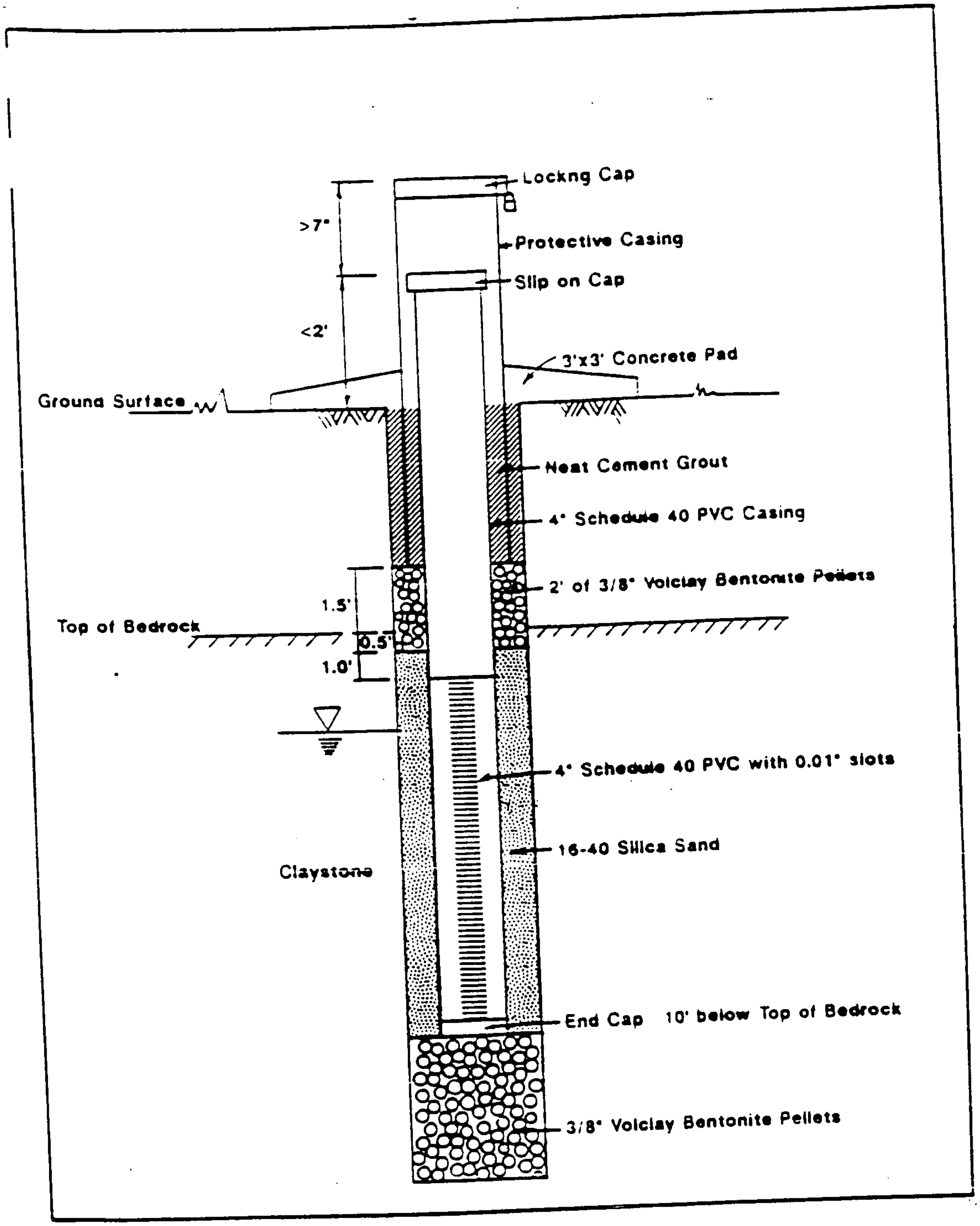
APPENDIX 5.2
TYPICAL ALLUVIAL MONITOR WELL CONSTRUCTION



TYPICAL ALLUVIAL MONITOR WELL CONSTRUCTION

APPENDIX 5.3

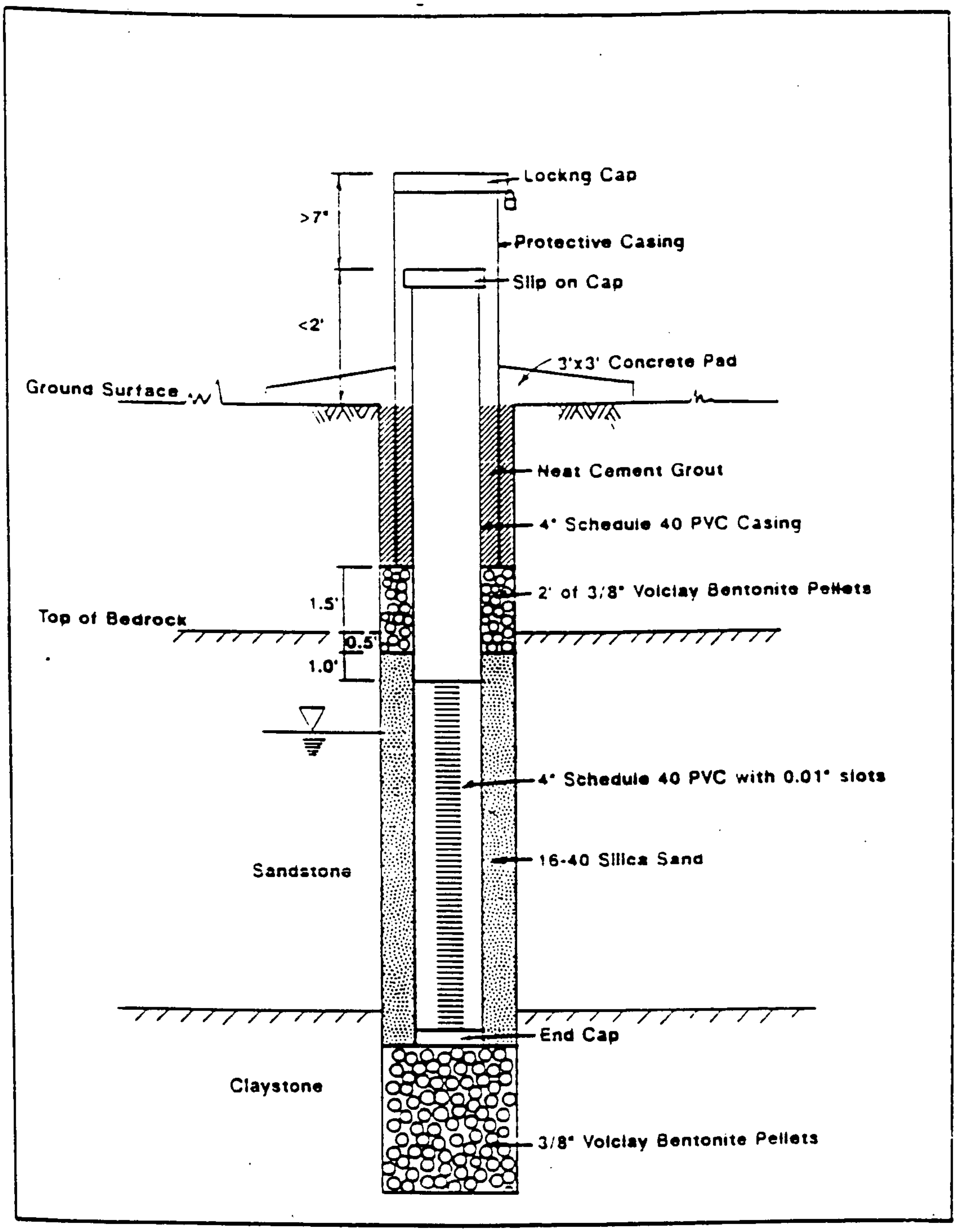
TYPICAL SHALLOW BEDROCK WELL CONSTRUCTION



TYPICAL SHALLOW BEDROCK WELL CONSTRUCTION
(weathered claystone)

APPENDIX 5.4

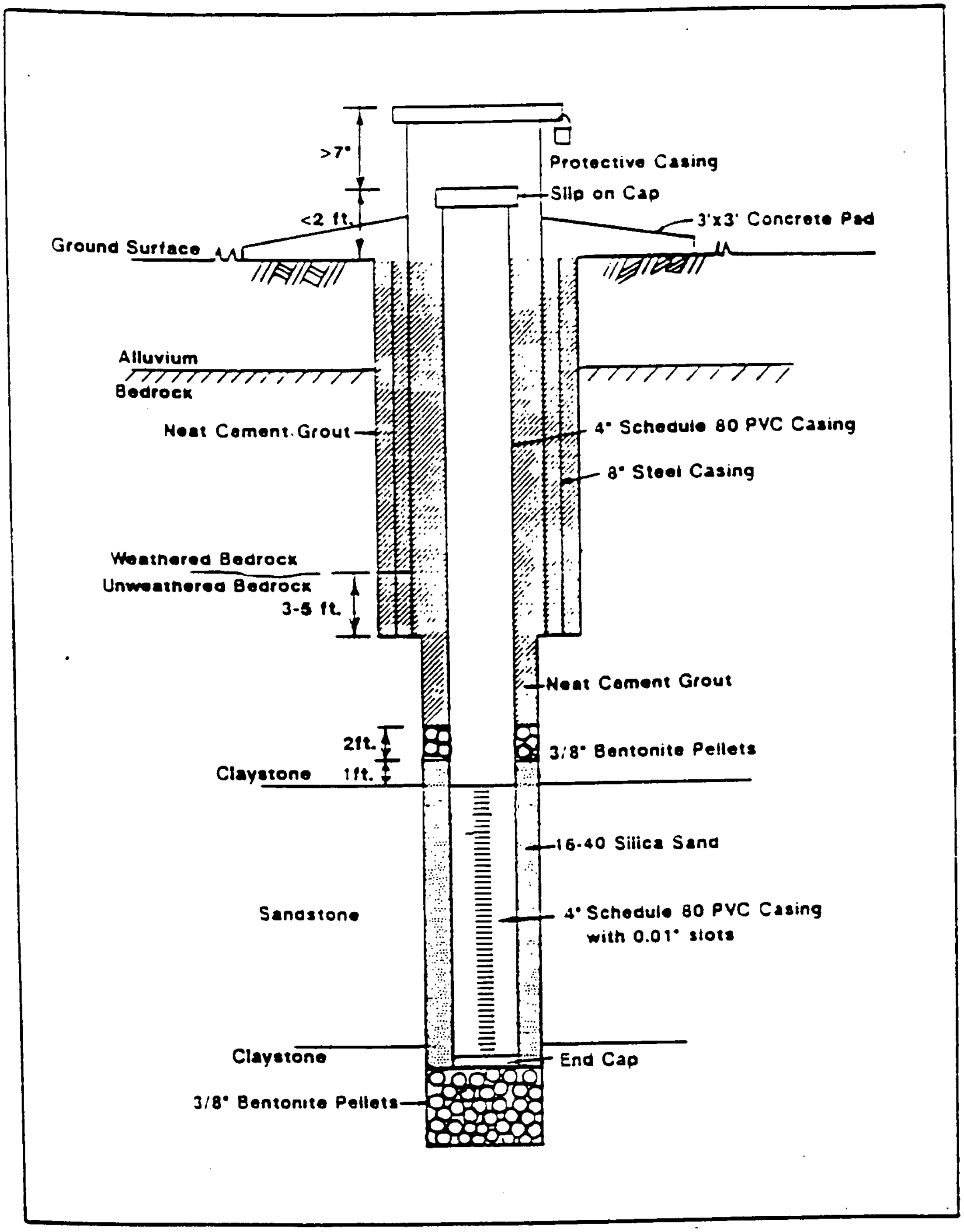
TYPICAL SHALLOW BEDROCK WELL CONSTRUCTION



TYPICAL SHALLOW BEDROCK WELL CONSTRUCTION
(weathered sandstone)

APPENDIX 5.5

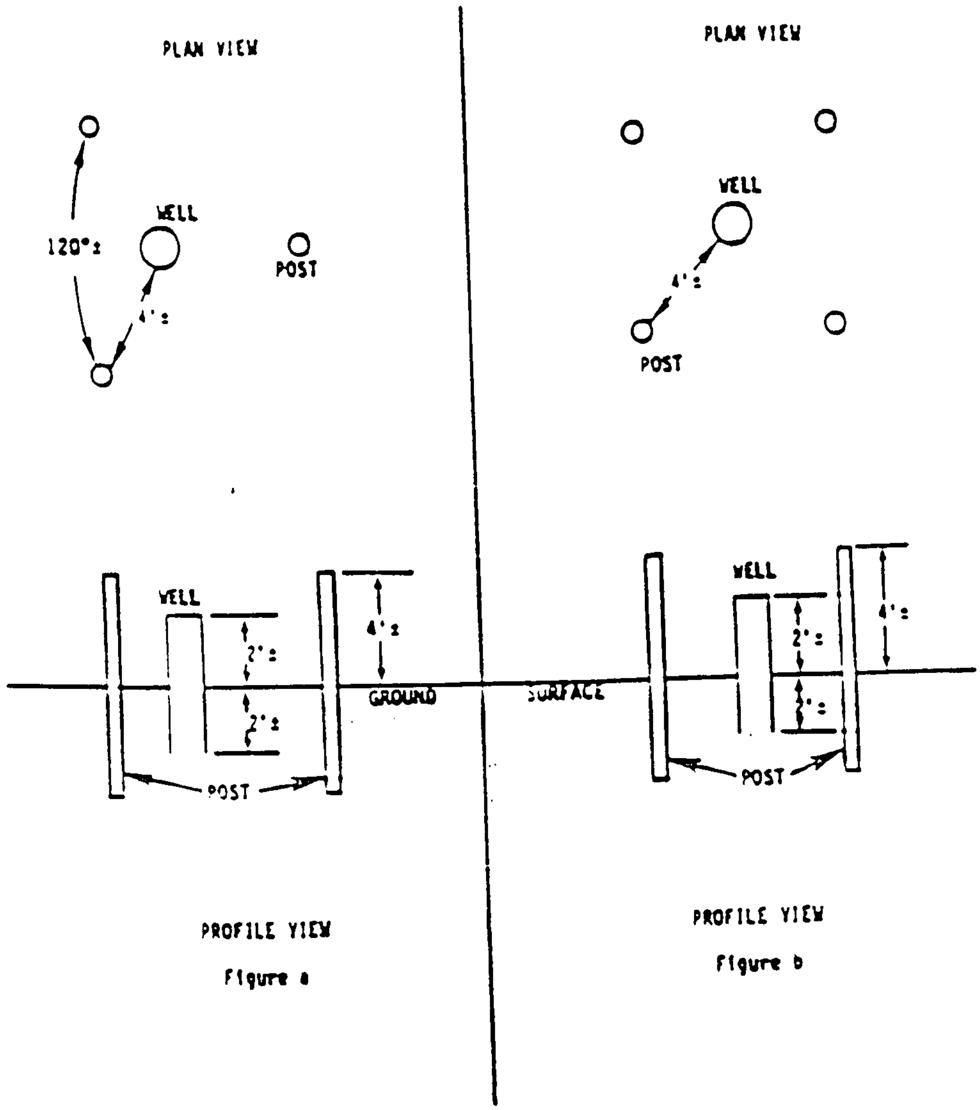
TYPICAL BEDROCK MONITOR WELL CONSTRUCTION



TYPICAL BEDROCK MONITOR WELL CONSTRUCTION
(unweathered sandstone)

APPENDIX 5.6

POST PLACEMENT AROUND WELL



PROFILE VIEW

Figure a

PROFILE VIEW

Figure b

APPENDIX 5.7

DATA FORM COMPLETION INSTRUCTIONS

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

WELL COMPLETION INFORMATION FORM

1. Location. Facility name and specific area of facility in which well is located.

2. Coordinates. Surveyed State Plane Coordinates for the monitor well.

3. Total Depth.

   Well. Total depth of monitor well as determined during construction.

   Borehole. Total depth the borehole was drilled (actual drilled footage).

4. Formation of Completion. Formation name of zone where monitor well is completed.

5. Casing Material. Type of material used for well string casing.

6. Screen Material. Type of material used for well string screen (including slot size).

7. Date Installed. Date(s) well was installed.

8. Installed By. Geologist's name.

9. Well No. Well Identification No.

10. Elevation.

    Ground Surface. Surveyed ground surface elevation

    Top of Casing. Surveyed elevation of the top of the inner well casing.

11. Casing Diameter. Diameter in feet (nearest 1/100th foot) of the inner well casing.

12. Surface Casing Diameter. Diameter in feet (nearest 1/100th foot) of the outer protective well casing.

13. Approved By. Signature of Site Manager. Signature of CEARP Manager.

14. Comments: Any additional information (i.e., centralizer location, etc.)

15. Specifications.

    A. Top of Casing. Surveyed stick-up.

    B. Surface Seal Material. Portland Type I cement, etc.

    C. Surface Seal Length. Length (in feet) of surface seal material.

    D. Bentonite Seal Length. Length (in feet) of bentonite seal.

    E. Filter Material. Filter pack size and constituent.

    F. Filter Pack Length. Length (in feet) of filter pack material.

    G. Backfill Length. Length (in feet) of material used to desired total depth.

    H. Backfill Material. Material used to backfill the borehole to desired total depth for completion.

    I. Surface Casing Depth. Depth (in feet) below ground surface that surface (protective) casing extends.

    J. Borehole Diameter. Diameter (in feet to the nearest 1/100th foot) of the drilled borehole.

    K. Top of Screen Depth. Depth (in feet to the nearest 1/100th foot) to the top of the actual screened interval (where slots begin).

    L. Screen Length. Length (in feet to the nearest 1/100th foot) of the actual screened section of the casing.

    M. Well Total Depth. Depth (feet to the nearest 1/100th foot) of the completed monitor well.

    N. Borehole Total Depth. Depth (feet to the nearest 1/100th foot) of the drilled borehole.

STANDARD OPERATING PROCEDURE 4.4

MONITORING WELL DEVELOPMENT

1. PURPOSE

To remove foreign materials that may have been introduced into the groundwater, well annulus, or well screen during well installation and to facilitate hydraulic communication between the screened formation and the monitoring well.

2. DISCUSSION

The Remedial Investigation Plan (RIP) contains specific details about the method and equipment to be used for developing the monitoring well. Collection and measurement of samples and documentation of data will be performed as described in the associated procedures.

Monitoring well development removes the fines from the borehole near the screen. There are four primary methods for developing monitoring wells: overpumping, rawhiding, jetting, and surging.

A. Overpumping involves pumping the well down as low as possible and allowing it to refill. The increased velocities created by refilling remove fines. This method is not very effective, because the water flow is in one direction and at relatively low velocities.

B. Rawhiding is a modification of overpumping. After the water is pumped to the surface, it is either allowed to run back into the well through a foot valveless pump or poured back down the well. This method generates two-directional flow and is superior to overpumping.

C. Jetting involves lowering a pipe into the well with a series of water jets on the end. The jets point horizontally. The high-pressure water pumped through the jets flushes fines from the formation and breaks the skin caused by drilling. As with the other methods, fines must occasionally be pumped from the well during development. An external water supply is needed for jetting. External water is introduced into the formation and alters the hydrochemistry. These are two major disadvantages of the jetting method.

D. Surging involves raising and lowering a surge or swab block inside the well. The resulting motion of the water removes the borehole skin and fines from the formation. The fines and water must occasionally be removed from the well with a sand bailer to prevent sand locking of the surge block. The rubber or viton seals on the surge block are the same diameter as the inside of the well or 1/2 inch smaller if surging is conducted inside the screened interval. A 3-ft stroke is typical.

   Surging can also be implemented with high-pressure air. A high-pressure air pipe is lowered into the well, and surges of air are introduced. Water may be literally blown out of the top of the well, and water can be pumped out as the air surging progresses. However, air surging can introduce air into the formation (altering the hydrochemistry) and become entrained in the screens (reducing flow rates). Plastic screens can also be damaged if the air surge is too violent. A specially fabricated air swab can be used to prevent these types of damage.

E. Surging with a vented (pressure-relief) block (Appendix 5.2) and rawhiding are the preferred methods for well development, although no one method is appropriate for all situations.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
2.2	Field Measurements on Ground and Surface Water Samples
3.1	Water Level Measurement
4.3	Monitoring Well Installation
6.1	Health and Safety Monitoring of Combustible Gas Levels
6.2	Health and Safety Monitoring of Organic Vapors with a Photoionization Detector
6.3	Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector

3.2. Preparation

3.2.1 Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Ensure that permission to discharge development water has been obtained or coordinate efforts to purchase appropriate containment vessels for development.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Decontaminate all equipment before developing each well according to SOP 1.6, General Equipment Decontamination.

B. Assemble containers for the temporary storage of water produced during well development. The containers must be structurally sound, compatible with anticipated contaminants, and field manageable.

NOTE: Truck-mounted tanks may be required for this operation.

3.3. Operation

Perform the development as soon as practical after well installation, but no sooner than 24 hrs after grouting is completed. Do not use any dispersing agents, acids, or disinfectants to enhance the development of the well. If problems or unusual conditions are encountered, notify the site manager as soon as possible.

A. Assemble the necessary equipment on a plastic sheet outside of the splash range.

B. Record pertinent information in the logbook and on the Well Completion Information form. A copy of this form and instructions for completing the form are provided in SOP 4.3, Monitoring Well Installation.

C. Open the monitoring well and take the air monitoring reading at the top of the casing and in the breathing zone (see SOP 6.1, Health and Safety Monitoring of Combustible Gas Levels; SOP 6.2, Health and Safety Monitoring of Organic Vapors with a Photoionization Detector; and SOP 6.3, Health and Safety Monitoring of Organic Vapors with a Flame Ionization Detector).

D. Measure depth-to-water and the total depth of the monitoring well according to SOP 3.1, Water Level Measurement.

E. The following well development procedures were derived from the current Rocky Flats Plant "L" procedures (SOP 2.1 - Appendix 5.1) for well development.

1. Note the initial color, turbidity, clarity, and odor of the water.

2. In order to develop the entire sand pack of a well, tap water will be added to the well to the level of the top of the filter pack. This accelerates development of wells with low recharge rates and/or completely unsaturated conditions.

3. The well will then be surged with a surge block seven to ten times, and water and sediment will be removed from the well with a dart valve bailer, sand pump, or bottom loading bailer. This process will be repeated three times (three well bore storage volumes). The volume of water removed from the well as well as the turbidity (using a turbidimeter) will be recorded after each well bore volume.

4. After removing three well bore volumes from the well, the well will be allowed to recover to within 75% of the original static water level. At this time, the formation water turbidity will be measured using a turbidimeter.

5. If the turbidity has stabilized from the last purge volume, the well is considered fully developed. If the turbidity of the well has not stabilized, then another well bore storage volume of tap water will be added and the surging process repeated. This process will be repeated until stabilization occurs.

6. Monitoring wells will be redeveloped if more than two inches of sediment exist in a well.

7. Complete the appropriate data entry requirements on the Well Completion Information form to document well development. A copy of the form and instructions for completing it are in SOP 4.3, Monitoring Well Installation.

3.4. Postoperation

3.4.1. <u>Field</u>

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to the presampling conditions as specified in the RIP.

C. Make sure all monitoring well locations are properly staked and the location ID is readily visible on the protective casing.

3.4.2. <u>Documentation</u>

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. After the first round of analytical results have been received, determine and implement the appropriate water disposal method.

B. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

C. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

D. If samples have been collected for analysis, contact the laboratory to ensure that samples arrived safely and instructions for sample analyses are clearly understood.

4. SOURCES

Barcelona, M. J., J. P. Gibb, J. A. Helfrich, and E. E. Garske. 1985. "Practical Guide to Groundwater Sampling." U.S. Environmental Protection Agency report EPA/600/2-85/104. Washington, D.C.: U.S. Government Printing Office.

Gass, Tyler E., "Monitor Well Development." 1986. Water Well Journal 40, no. 1: 52-55.

Schalla, Ronald, and Robert W. Landick. 1986. "A New Valved and Air-Vented Plunger for Developing Small Diameter Monitor Wells," Ground Water Monitoring Review 6, no. 2: 77-80.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Surge Block Schematics

5.3. Well Development Summary Sheet

5.4. Data Form Completion

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Distilled water
- ________ Stopwatch
- ________ Water level measurement probe
- ________ Turbidimeter
- ________ Plastic sheet

APPENDIX 5.3

WELL NO.:

WELL DEVELOPMENT SUMMARY SHEET

QA Review By/Date:

Location:

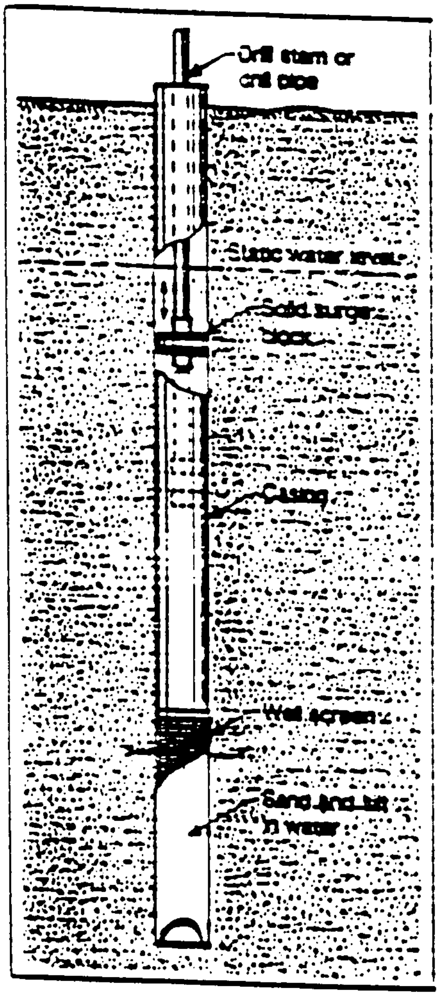
W.O.#

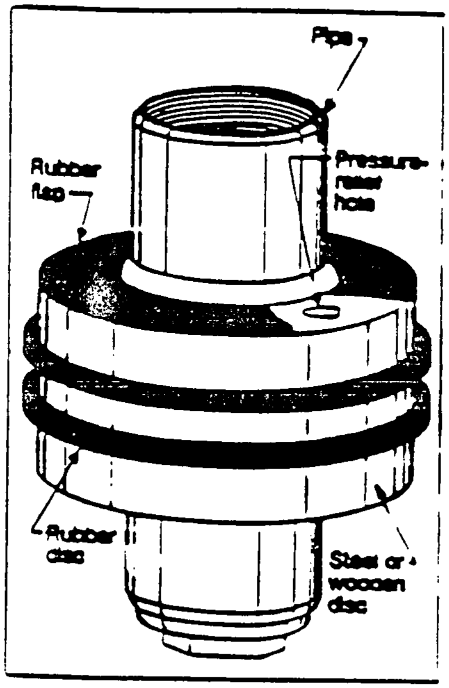
DATE	TIME	METHOD	VOLUME	APPEARANCE	BY	COMMENTS

Page: of

APPENDIX 5.2

SURGE BLOCK SCHEMATICS





APPENDIX 5.4

DATA FORM COMPLETION

Use a +pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown. NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

WELL DEVELOPMENT SUMMARY SHEET

1. Well No. Monitor well ID Number.

2. QA Review By/Date. Signature of person completing QA of the form followed by the date the QA was completed.

3. Location. Facility name and specific area of the facility that the well is in.

4. W.O.#. Work order or job number.

5. Documentation.

   A. Date. Date of development of the well.

   B. Time. Military time that development began.

   C. Method. Development method (i.e., bailer, bladder pump, surge & block, etc.)

   D. Volume. Volume of water evacuated from the well.

   E. Appearance. Color and turbidity of the water being evacuated.

   F. By. Initials of person performing the well development.

   G. Comments. Any additional information.

STANDARD OPERATING PROCEDURE 4.5

BOREHOLE GEOPHYSICAL LOGGING

1. PURPOSE

To provide guidelines for geophysically logging boreholes.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information about the borehole logging requirements for a given site. Geophysical techniques have proven to be valuable tools in determining lithologies, porosities and moisture regime of various stratigraphic units. This information is useful in the decision making process for choosing monitoring well completion intervals. The suite of logs to be run is determined by the data requirements of the study. The following is a brief description of various commonly run probes.

Sonic Probe - A sonic log shows travel times of acoustic waves through rock in microseconds. The 18 or 36-inch transmitter-to-receiver (Tx-Rx) spacing used for this program allows the log to show extreme detail of the borehole wall. As discontinuities, such as weathered partings and cavities, come between the transmitter and receiver, travel times change drastically and cause distortion of the compressional (or P-) wave.

The thickness of the discontinuity can be measured by subtracting 18 scale inches for the 18-inch spacing from the distorted wave front. For example, if the recorded vertical distortion is 28 scale inches, the discontinuity is approximately 10 inches thick. This evaluation has been substantiated by recording sonic logs in core holes and comparing the results with discontinuities found in core samples.

Caliper Probe - The caliper probe is a single arm mechanical probe that is used to determine variation in the diameter of a borehole. The diameter generally increases in cavities and, depending on the drilling technique used, in weathered zones. An apparent decrease in borehole diameter may result from mud or drill-cutting accumulation along the sides of the borehole and in the bottom of a boring. Data from the caliper log is used (1) to vertically locate cavities and weathered zones and (2) to correct changes in borehole diameter which directly affects the response of the gamma-gamma log and the sonic log. The caliper probe may also be used to determine the condition and variation in diameter of casing.

Gamma-Gamma Probe - The single arm caliper probe is used to decentralize the gamma-gamma probe against the wall of the borehole or against the inside wall of well casing. As the gamma-gamma probe is drawn up through the borehole, gamma rays are radiated from a radioactive source (Cesium-137) into the surrounding material. Some rays are scattered and absorbed by collisions with electrons within the material; whereas other rays return to a radiation detector and are counted. The number of returned rays is inversely proportional to the approximate bulk density of the surrounding material. Densities of rock along the walls of a borehole are identified by a number of counts per second with a lesser density giving higher counts. By using a compensated density probe (2 detectors) and calibrating the system to known values, the counts can be translated to actual density values.

Natural Gamma Probe - The natural gamma probe detects gamma radiation that naturally occurs in all rock and records the radiation in counts per second. The log, which shows relative changes in radiation is used for lithologic identification and stratigraphic correlation and is not directly sensitive to weathering. Siltstone, for example, is identified by a higher count rate than limestone.

Electric Probes - The Guard Resistivity probe contains a wire coil and two closely spaced electrodes. In a fluid-filled boring, the coil measures the relative resistivity, in ohm-m, of the fluid which corresponds to the resistance of the surrounding strata. This log can be used for stratigraphic correlation for site characterization programs. Formation water resistivity can also be determined from this log.

The Single-Point Resistance log measures a direct contact with the formation with respect to a surface reference point. The relatively shallow radius of investigation (3" -5 ") enables precise recording of formation contacts. However, the log response, measured in ohms, is strongly affected by lithology, the resistance of the drilling fluid and the rugosity of the borehole.

The Spontaneous Potential (SP) probe basically utilizes the same electronic configuration as the Single-Point Resistance and is used to measure variations in the natural electrochemical potential. The potential, (electrochemical) measured in millivolts, results if a contrast exists between the resistivities of the borehole fluid and the formation pore water. It can also result from oxidation-reduction (redox) from sulfide mineralization (e.g. pyrite) or from a "streaming" potential which results from fluid flow into or out of the formation.

Another resistance probe is the 16-inch normal. This probe utilizes current and potential electrodes in the borehole and on the surface.

In general, the resistivity logs are mainly used for lithologic identification and determining bed thickness. The SP and 16-inch normal can be reviewed to provide supportive hydrogeologic information.

Neutron Probe - As the neutron probe is drawn up the borehole, neutrons are emitted from an Americium-241 Beryllium source into the surrounding strata. Some of these neutrons are slowed down or thermalized, by collisions with atomic nuclei in the surrounding strata, while other neutrons are returned to a detector and are recorded in counts per second. Because hydrogen is the most effective thermalizing element, a decrease in returned neutrons indicates an increase in hydrogen which in turn implies an increase in porosity for clean sediments below the water table. Clayey sediments contain chemically bound hydrogen which thermalize neutrons.

Temperature Probe - The first probe used in any borehole is usually the temperature probe. This probe continuously records the thermal gradient of the borehole fluid immediately surrounding the thermistor as the probe is lowered from the surface to the bottom of the hole.

The logging equipment is calibrated to present data in degrees Celsius. Temperature data provides information as to the source of inner borehole flow and static water levels.

Fluid Resistivity Probe - Fluid resistivity logs record the borehole fluid resistivity directly as the borehole fluid passes between electrodes within the probe. Changes in fluid resistivity can indicate the in-flow or out-flow of water as well as the water quality.

PROCEDURE

3.1. Associated Procedures

Information that applies to most field activities is provided in SOPs 1.1-1.10. In addition to the RIP, those SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
5.1	Soil and Rock Borehole Logging and Sampling
6.5	Screening Samples for Alpha Emitters

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment. Make sure that the calibration dates are current.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check and calibration dates in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Record all information necessary to correctly interpret the log on the heading including:

- o Well ID Number;
- o Project Number;
- o Client;
- o Bit size;
- o Casing size;
- o Location of the zero-depth of the log, which may be the top of the casing, ground level, or some other specified point;
- o Height of the top of the casing above ground level;
- o Depth of the bottom of the casings;
- o Total depth drilled;
- o Type and level of drilling fluid;
- o Date of logging;
- o Logging engineer;
- o Logging speed;
- o Time-Constant, where appropriate;
- o Calibration and standardization data;
- o Logging tool serial numbers; and
- o Any additional pertinent information.

B. Determine and record the source-to-detector distance for nuclear radiation tools and the focusing width for focused resistivity tools.

C. In resistivity logging, sample the drillhole fluid and record its resistivity so that true resistivity for the strata can be calculated.

D. Clearly record calibration and standardization marks on all logs to demonstrate the relationship between the log scale and standard calibration procedures.

E. Assemble the downhole logging tool.

F. Decontaminate logging tool and cable (See SOP 1.6, General Equipment Decontamination).

3.3 Operation

A. Set-up and conduct pre-calibration procedures.

B. Start the built-in generator.

C. Rig up a hanging or table sheave wheel pulley on the drill rig as appropriate.

D. Measure the temperature, salinity, and conductivity of the drill fluid if possible.

E. Assemble the probe to be run, attach the probe to the cable head, and calibrate the tool if appropriate.

F. Set the probe into the well bore and lower to the depth requested.

G. Check the zero and span calibrations of the analog chart recorded if it is being used for real-time log response display.

H. Begin the logging sequence.

1. Generally, the temperature and fluid resistivity probe would be the first probe run. Logging speed must be constant and slow enough so that temperatures accurately represent true depths on the log. The logs are collected while lowering the probe in the borehole as passage of the probe through the center column disturbs the thermal regime.

2. Spontaneous Potential, Electric and/or the natural gamma are typically the second probe run in the borehole.

   a. For electric measurements, a test box with known resistor values and clip leads to attach to the various electrodes, surface electrode (mud plug), and cable armor would be utilized to determine that proper values are observed and recorded.

   b. To field test the natural gamma function, place a low-level gamma source sleeve over or near the gamma detector to observe typical count rates.

   c. Repeat sections of the natural gamma logs and electric logs would be recorded as appropriate to ascertain that selected logging parameters are providing optimum response.

3. The full-waveform sonic probe would be the third probe run in the borehole.

a. Perform an operation check by listening for the audible clicking of the transmitter and gently scratching the two receivers with fingernails to observe a signal.

b. An oscilloscope is routinely used to observe the output signals while logging.

c. Repeat sections would be recorded as appropriate to ascertain that selected instrument settings are providing optimum response.

4. Guard Resistivity, Neutron, and Natural Gamma would be the next signals to be recorded.

   a. To field test the natural gamma function, place a low-level gamma source sleeve over or near the gamma detector to observe typical count rates.

   b. The Guard resistivity function is field checked with a test box containing known resistor values and clip leads as described in 3.3, H2.

   c. A radiation survey in the immediate vicinity of the drill site will be conducted by the logging operator to determine and record the existing background total count radiation level prior to removing either the neutron or gamma-gamma source from its storage shield.

   d. A similar survey will be performed after the logging operator has replaced the last source in its shield.

   e. Repeat sections would be run as appropriate to ascertain that instrument settings and logging speed provide optimum resolution.

5. Gamma-Gamma density and caliper logs would comprise the next logging run

   a. A radiation survey in the immediate vicinity of the drill site will be conducted by the logging operator to determine and record the existing background total count radiation level prior to removing either the neutron or gamma-gamma source from its storage shield.

   b. A similar survey will be performed after the logging operator has replaced the last source in its shield.

   c. Calibrate the gamma gamma density function by taking and recording readings with the probe in both an aluminum and lucite calibration block set.

   d. Calibrate the caliper logs by using standard reference collars.

   e. Repeat sections would be run as appropriate to ascertain that instrument settings and logging speed are providing optimum response.

6. Geonics EM-39 induction instrument is completely independent from the other probes and modules.

3.4. Postoperation

3.4.1 Field

A. Ensure that all equipment is accounted for and decontaminated (See SOP 1.6, General Equipment Decontamination).

B. Make sure all borehole locations are properly staked and the location ID is readily visible.

C. Provide the field team leader with all completed Log of Borehole forms.

D. Logging operator will provide a draft copy of each log as well as a copy of the original "raw" digital log data to the field team leader before leaving the plant site.

3.4.2 Documentation

A. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

B. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the document control officer (with copies to the site manager and files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Supply geophysical subcontractor all necessary information for generation of summary plots and fence diagrams when appropriate.

D. Interpret well logs in order to determine the information required for the project.

E. A reproducible mylar film and five copies of the final logs and processed digital data on compatible floppy disks will be provided by the logging engineer to the field team leader.

4. SOURCES

Tennessee SSC Site Geological and Hydrological Testing Program. Appendix H., May 12, 1988. Edited by P.D. Manhardt., Tennessee Technology Foundation. Knoxvlle, Tennessee.

Geophysical Borehole Logging Handbook for Coal Exploration. G.L. Hoffman, G.R. Jordon & G.R. Wallis. Published by The Coal Mining Research Centre, Edmonton, Alberta, Canada 1982. Library of Congress Cat. Card No. ISBN 0-9691048-0-4.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Logging Report

5.3. Processing Report

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Downhole probes
- ________ Surface modules and analog chart recorder
- ________ Logging vehicle
- ________ Geonics EM-39 portable borehole induction logging system
- ________ 3/16" four-conductor steel armored logging cable
- ________ Logging Report Forms
- ________ Processing Report Forms
- ________ Gamma Check Source
- ________ Tape
- ________ Measuring Tape
- ________ Indelible Marker
- ________ Hand-held calculator

APPENDIX 5.2

LOGGING REPORT

PROBE INFORMATION

Neutron Probe Radioactive Source:

Type__________ Strength__________ Curies________

Spacing Between Source and Detector _____ inches

S/N of Probe ________ S/N of Source ________

Gamma-Gamma Probe Radioactive Source:

Type__________ Strength__________ Curies ________

Spacing Between Source and Detector _____ inches

S/N of Probe ________ S/N of Source ________

Neutron Gamma Probe:

Time Constant__________ Logging Speed__________ft/min..

Recorder Sensitivity___________ Zero Positioning.

S/N of Probe ________ S/N of Source ________

APPENDIX 5.2, Concluded

LOGGING REPORT

LOGGING REPORT

DATE ______ PAGE ____ OF ____

ENGINEER(S) ______

TRUCK ______

WELL # ______ PROJECT ______ CLIENT ______

LOCATION ______ ELEV. ______ DEPTH REF. ______ WITNESS ______
(State) (County) (Qtr. Sec.) (Sec.) (Twp.) (Rgn.)

DRILLING CONTRACTOR ______ TYPE DRILL ______

DRILLER TD. ______ COMMENTS ______

BIT SIZE ______ from ______ to ______ BASE ______ ADDITIVES ______

Rm= ______ at ______ Time sample taken

Salinity ______ at ______ weight ______ lb. viscosity ______ sec.

CASING SIZE ______ from ______ to ______ Rmf= ______ at ______ Rmc= ______ at ______

Sample taken from ______

Hours since circulation stopped ______

RUN NO.	TOOLS	SPEED FT/MIN	TIME START / STOP	DEPTH BOT. LOG / TOP LOG	AFTER SURVEY DEPTH ERROR	DIGITAL FILE NAME / DIGITAL INTERVAL	REMARKS	FLUID LEVEL
	MODEL: S.N. MODULE S.N.							
	MODEL: S.N. MODULE S.N.							
	MODEL: S.N. MODULE S. N.							
	MODEL: S.N. MODULE S.N.							
	MODEL: S.N. MODULE S.N.							
	MODEL: S.N. MODULE S.N.							
	MODEL: S.N. MODULE S. N.							
	MODEL: S.N. MODULE S.N.							

APPENDIX 5.3

PROCESSING REPORT

PROCESSING REPORT

PAGE ___ OF ___

WELL # ____________ PROJECT ____________ DATE (RECORDED) ____________

FIELD COMPUTER ________ PROC. COMPUTER ________ LOGGING ENG. ________ PROCESSED BY ________

INPUT FILE	OUTPUT FILE	DATE	PROCESSING STEPS

FINAL FILE NAMES: ____________

HEADER FILE NAMES: ____________

PLP FILE NAMES: ____________

ARCHIVE FILE NAMES: ____________

ARCHIVE TYPE: ____________ VOL. NO. ____________

DATA DISTRIBUTION ____________

STANDARD OPERATING PROCEDURE 5.1

SOIL AND ROCK BOREHOLE LOGGING AND SAMPLING

1. PURPOSE

To describe the physical nature of consolidated or unconsolidated subsurface earthen materials encountered during auger, rotary, or other drilling activities and collect samples of the earthen materials for further evaluation.

2. DISCUSSION

The Remedial Investigation Plan (RIP) contains specific details about the procedures and equipment for this SOP. Refer to the RIP for the type of samples to be collected. Collection and measurement of samples and the documentation of data will be performed as described in the associated procedures.

Before field drilling begins, all management personnel should obtain information about expected geologic and hydrogeologic conditions at the site. The RIP includes directions for sampling methods, location, and details for the site where the field personnel will work.

Most sites where soil and rock borehole logging and sampling are conducted include unconsolidated deposits of varying thickness over consolidated bedrock at depth. The Log of Borehole form (Appendix 5.2) will be used for recording lithologic descriptions of both soils and rocks.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information on equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation
1.4	Sample Containers and Preservation
1.5	Guide to Handling, Packaging, and Shipping of Samples

SOP No.	SOP Title
1.6	General Equipment Decontamination
4.1	Soil Boring
4.2	Rock Boring

3.2. **Preparation**

3.2.1. **Office**

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

F. Contact the carrier that will transport samples to obtain information on regulations and specifications.

G. Contact the members of the survey crew and inform them of the approximate date that ground surveys will begin.

3.2.2. **Documentation**

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. **Field**

A. Decontaminate all sampling equipment before taking the first sample and between sampling intervals (see SOP 1.6, General Equipment Decontamination, and the RIP).

B. Record all pertinent information (date, site, ID number, and location) in the logbook or the appropriate data form. Note field conditions, unusual circumstances, and weather conditions.

C. Permanently attach a soil sample identification label to each sample container.

3.3. Operation

3.3.1. Logging Samples

A. Whenever a sample is collected, complete a description of the sample using the Log of Borehole form (Appendix 5.2) Fill out these forms according to the information described in Appendix 5.3. Include all scale drawings that further describe textural variations in the logbook. If cameras are permitted on the site, use photographs instead of drawings.

NOTE: Whenever a sample is collected for laboratory analysis, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a Soil Sample Identification Label affixed to the sample container. SOP 1.3, Sample Control and Documentation, contains copies of the form and label as well as instructions for completing the form and label.

B. Gross physical properties of the sample can be described by unaided visual observation or inspection under a hand lens. Whenever feasible, prepare sample descriptions by observing fresh surfaces or cuttings.

C. Wash cuttings from mud rotary boring in clear water to remove drilling mud. Use a strainer with a large capacity during the washing process.

D. Split the core lengthwise, so that the interior can be inspected when possible. Place core in cardboard box after inspection. Label top, bottom, and core interval on box. The core box will be lined with plastic to minimize cross-contamination. Mark unrecovered core intervals with blocks of wood. Use two permanent markers of different colors to draw parallel lines on the core so that its proper position in the core box can be maintained during and after future inspections when possible (optional).

E. Record all linear measurements in feet or tenths of feet, not inches.

F. Blow counts are to be counted for each 0.5-ft penetration of the split spoon samples during the Standard Penetration Test.

G. Percent core recovery is a measure of coring efficiency and rock quality. If coring progresses gradually, a hard sandstone to a strongly fissile shale, the percent recovery will be affected. Once the core is shown to the field representative (preferably while still in the core barrel if it is a split-core barrel), measure the total length recovered. Sometimes it is possible to determine where core loss occurred in the run. The following clues are sometimes present: plugging off during drilling, intense fracturing in certain sections of core (possibly correlated with rough, high vibrations during drilling), and rolled and recut pieces of core.

H. The rock quality designation (RQD) is based on a modified core recovery procedure and indirectly on the number of fractures and the amount of softening or alteration in the rock mass. Obtain the measure by summing up the total length of core recovered and counting only those relatively hard, sound pieces of core that are four inches in length or longer. See Stags and Zienkiewitz (1968) for an example of an RQD computation. It is necessary to distinguish between natural fractures and those caused by drilling or recovery operations. Depending on the engineering or hydrogeologic requirements of the project, breaks induced along highly anisotropic planes (like foliation or bedding) may be counted as natural fractures. Lengths that contain strong and recemented fractures should be measured in total.

RQD	QUALITY OF ROCK MASS
90-100	Excellent
75-90	Good
50-75	Fair
25-50	Poor
0-25	Very Poor

I. Percent Drilling Fluid Recovery--the volume of fluid losses and the interval over which they occur. For example, no fluid loss means that no fluid was lost except through spillage and filling the hole. Partial fluid loss means that a return was achieved, but the amount of return was significantly less than the amount being pumped. Complete fluid loss means that no fluid returned to the surface during the pumping operation. A combination of opinions from the field personnel and the driller on this matter will result in the best estimate. Make a crude, relatively effective estimate by placing a calibrated stick in the recirculation pit. Estimate the return flow and volume of the pit at intervals of one-half ft to one ft on the stick.

Record the percent drilling fluid recovery using the terms "no fluid loss," "partial fluid loss," or "complete fluid loss," as defined above for every five ft run.

J. Spacing. Describe the spacing of discontinuities as close or wide according to the following tables.

SPACING	FOLIATION, BANDING, OR BEDDING	SYMBOL
(1) More than 6 ft	Very thickly (bedded or banded)	VT
(2) 2 to 6 ft	Thickly	T
(3) 8 to 24 inches	Medium	M
(4) 2 1/2 to 8 inches	Thinly	TN
(5) 3/4 to 2 1/2 inches	Very thinly	VT

In describing structural features, describe the rock mass as thickly bedded or thinly bedded according to the above criteria. Depending on the project requirements, identify the form of joint (stepped, smooth, undulating, or planar), its dip (in degrees), its surface (rough, smooth, or slickensided), its opening (giving width), and its filling (none, sand, clay, or breccia).

K. Dip Angle. The Dip Angle is the angle of bedding, joints, or fractures from horizontal measured with a clear plastic protractor to the nearest 1°. Reference all measurements with 0° at horizontal.

L. Condition. The texture of the fractures. Examples of condition are smooth, clean, rough, and stained, and slickensided.

M. Weathering. Describe the degree of weathering according to the following table.

GRADE	SYMBOL	DIAGNOSTIC FEATURES
Fresh	F	No visible sign of decomposition or discoloration.
Slightly	SLW	Slight discoloration inward from open fractures; otherwise, similar to fresh.
Moderately Weathered	MW	Discoloration abundant. Weaker minerals (like feldspar) have decomposed. Texture has been preserved.
Highly Weathered	HW	Discoloration throughout. Most minerals are somewhat decomposed. Texture becoming indistinct, but fabric has been preserved.
Completely	CW	Minerals decomposed to soil, but fabric and structure have been preserved (saprolite). Easily crumbled or penetrated. Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

CAUTION: Soft rock is not necessarily weathered. Look for alteration minerals that indicate true weathering has occurred.

N. Hardness. Describes the degree of hardness according to the following table.

CLASS	HARDNESS	SYMBOL	FIELD TEST
I	Extremely hard	EH	Many blows with geologic hammer required to break intact specimen.
II	Very hard	VH	Hand-held specimen breaks with hammer end of pick under more than one blow.
III	Hard	H	Cannot be scraped or peeled with knife; hand-held specimen can be broken with single moderate blow with pick.
IV	Soft	SO	Can just be scraped or peeled with knife. Indentations 1 mm to 3 mm show in specimen with moderate blow with pick.
V	Very soft	VSO	Material crumbles under moderate blow with sharp end of pick and can be peeled with a knife, but specimen is too hard to hand trim to a size usable in a triaxial test apparatus.

O. Lithologic. The type of strata encountered during various subsurface exploratory investigations.

P. Visual Description. Other petrologic descriptors that aid in the classification of the rock or soil. Information that should be included is listed below. (See Appendix 5.4 - Checklist for Lithologic Descriptions).

Q. Place samples for analyses in appropriate containers (see SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples). Designate sample intervals removed from core by wooden blocks that have been properly labeled according to the interval sampled.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to presampling conditions and plug open sampling holes, as specified in the RIP.

C. Make sure all borehole locations are properly staked and the location ID is readily visible on the location stake.

D. Prepare samples and transport according to SOP 1.3, Sample control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

3.4.2. Documentation

A. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that samples arrived safely and instructions for sample analyses are understood.

4. SOURCES

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ASTM. 1986. "Standard Practice for Diamond Core Drilling For Site Investigation," 333-337, ASTM D: 2113-83. American Society of Testing Methods, Philadelphia, Pennsylvania.

ASTM. 1986. "Standard Test Method for Classification Of Soils For Engineering Purposes," 397-410, ASTM D: 2487-85. American Society of Testing Methods, Philadelphia, Pennsylvania.

ASTM. 1986. "Standard Recommended Practice for Description of Soils (Visual-Manual Procedure)," 411-25, ASTM D:2488-84. American Society of Testing Methods, Philadelphia, Pennsylvania.

ASTM. 1986. "Standard Practice for Ring-Lined Barrel Sampling of Soils," 560-563, ASTM D: 3550-84. American Society of Testing Methods, Philadelphia, Pennsylvania.

U.S. Corps of Engineers. 1953. "The Unified Soil Classification System." Technical Memorandum No. 3-357. Washington, D.C.: U.S. Government Printing Office.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Log of Borehole

5.3. Data Form Completion

5.4. Checklist for Lithologic Descriptions

5.5. Grain Size Chart

5.6. Degree of Sorting and Grain Shape Chart

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

_________ Plastic sheet

_________ Hand lens

_________ Tape measure (divided by feet and tenths of feet)

_________ Wooden blocks (for core)

_________ Core boxes

_________ Grain-size chart

_________ Color chart

_________ Dilute HCl

_________ Red and blue permanent markers

_________ Strainer

_________ Sample labels

APPENDIX 5.2

LOG OF BOREHOLE

LOG OF BOREHOLE

Location ____________________ Borehole/Well No. ____________________

Coordinates ____________________ Ground Surface Elevation ____________________

Total Depth ____________________ Water Level Encountered ____________________

Static ____________________

Drilling Company ____________________ Driller __________ Helper __________

Date Drilled ____________________ Drilling Fluid ____________________

Drilling Method ____________________ Checked By ____________________

Site Manager

Logged By ____________________

Geologist

____

CEARP Manager

Comments ____

____

Depth Feet	Graphic Log	Sample Type	Lithologic Description	Samples Collected or Other Tests Performed
0				
2				
4				
6				
8				
10				

APPENDIX 5.3

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

LOG OF BOREHOLE

1. Location. Facility name and specific area in which monitor well/borehole is located.

2. Coordinates. Surveyed State Plane Coordinates for the monitor well/borehole.

3. Total Depth. Total depth (ft to the nearest 1/100th ft) that the borehole was drilled.

4. Drilling Company. Name of the company performing the drilling activities.

5. Drilling Method. Drilling method used (i.e., hollow stem auger, rotary core, casing driver, etc.).

6. Logged By. Geologist's name.

7. Borehole/Well No. Borehole or well ID number.

8. Ground Surface Elevation. Surveyed ground surface elevation.

9. Water Level Encountered. Depth below ground surface that saturated materials where encountered during drilling.

10. Static water level. Static water level (depth) in the monitor well. Determined following well completion.

11. Driller. Driller's name.

12. Helper. Driller's helper's name.

13. Drilling Fluid. Type of drilling fluid used. If none was used, write "None".

14. Checked by. Signature of Site Manager; Signature of CEARP Manager.

15. Graphic log. Graphic representation of the lithologic description.

16. Sample Type. Graphic representation of the method used to collect the samples during drilling.

APPENDIX 5.3, Concluded

17. Lithologic Description (See SOP 5.1 - Appendix 5.4 - Checklist for Lithologic Descriptions). Sample interval: major constituent, color, sorting, grain size, grain shape, moisture content, etc.

18. Samples collected or other tests performed. Record samples collected for geotechnical or chemical testing, or any other field tests performed (i.e., record blow counts, packer test intervals, etc.).

APPENDIX 5.4

CHECKLIST FOR LITHOLOGIC DESCRIPTIONS

1. Local or Geologic Name

2. Sample Interval

   Depth of sample run (e.g. 5.10 - 10.05')

3. Recovery

   Actual length of materials in sampler (ft) divided by the length of the sample run (ft) multiplied by 100 to get percent recovery.

4. Rock Quality Designation (for core only)

   Rock Quality Designation (RQD.) The RQD is computed by summing the lengths of all pieces of core equal to or longer than 4 inches and dividing by the total length of core recovered from the sample run. The result is multiplied by 100 to yield the RQD in a percentage form.

$$RQD(\%) = \frac{\text{Sum of length (ft)} > 4 \text{ inches}}{\text{Total length of recovered core (ft)}} \times 100$$

5. Typical Name

   Sandy silt, silt, clayey silt, sandy clay, silty clay, clay, organic silt, organic clay, or fill

6. Color

   Note presence of mottling and banding, as well as soil color using the GSA Rock Color Chart

7. Structural Characteristics

   Stratified, laminated (varved), fissured, blocky, lensed, or homogeneous (nonstratified)

8. Grain Size

   Approximate percent gravel, sand, and fines. Grain sizes will be classified according to the wentworth scale (Appendix 5.5) The percentage of each grain size will be denoted by the following descriptive terms.

Descriptive Term	Percentage
Trace	1-10%
Some	10-20%
Adjective (Sandy, silty, etc.)	20-35%
"And"	35-50%

9. *Degree of Sorting*

The degree of sorting is a measure of particle size uniformity. It will be visually estimated in the field using the chart shown in Appendix 5.6.

10. Grain Shape (Roundness)

Roundess is the degree of abrasion of a clastic particle and is reflected in the sharpness of its edges and corners. Grain shapes will be determined visually in the field using the chart shown in Appendix 5.6

11. Composition of Grains

Composition of grains will be described by using the major or dominant grain component first, followed by minor component percentages or the appropriate descriptive term.

12. Minor Characteristics

Minor and/or unusual characteristics of a sample will be noted in the description.

13. Degree and Nature of Cementation

The degree of cementation will be recorded as uncemented, poorly cemented, or well cemented based on visual inspection. The nature of cementation will be determined based on the reaction of samples to dilute hydrochloric acid. The intensity of the hydrochloride acid reaction will be described as no reaction, weak reaction, or strong reaction.

14. Consistency

Soft, firm (medium), stiff, very stiff, or hard

15. Moisture Content

A general qualitative description will be used to describe moisture content:

Dry: No dists
cernible moisture present

Damp: Enough moisture present to darken the color of the sample, but does not feel moist to the touch.

Moist: Sample feels moist to the touch.

Wet: Visible water is present.

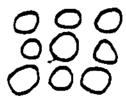
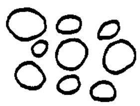
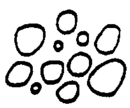
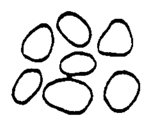
APPENDIX 5.5

GRAIN SIZE CHART

U. S. Standard Sieve Mesh //		Millimeters	Microns	Phi (ϕ)	Wentworth Size Class	
				-20		
		4096		-12		
		1024		-10	Boulder (-8 to -12ϕ)	
Use		256		-8		GRAVEL
wire		64		-6	Cobble (-6 to -8ϕ)	
squares		16		-4	Pebble (-2 to -6ϕ)	
5		4		-2		
6		3.36		-1.75		
7		2.83		-1.5	Granule	
8		2.38		-1.25		
10		2.00		-1.0		
12		1.68		-0.75		SAND
14		1.41		-0.5	Very coarse sand	
16		1.19		-0.25		
18		1.00		0.0		
20		0.84		0.25		
25		0.71		0.5	Coarse sand	
30		0.59		0.75		
35	1/2	0.50	500	1.0		
40		0.42	420	1.25		
45		0.35	350	1.5	Medium sand	
50		0.30	300	1.75		
60	1/4	0.25	250	2.0		
70		0.210	210	2.25		
80		0.177	177	2.5	Fine sand	
100		0.149	149	2.75		
120	1/8	0.125	125	3.0		
140		0.105	105	3.25		
170		0.088	88	3.5	Very fine sand	
200		0.074	74	3.75		
230	1/16	0.0625	62.5	4.0		
270		0.053	53	4.25		
325		0.044	44	4.5	Coarse silt	
		0.037	37	4.75		
	1/32	0.031	31	5.0		
Analyzed	1/64	0.0156	15.6	6.0	Medium silt	
	1/128	0.0078	7.8	7.0	Fine silt	
by	1/256	0.0039	3.9	8.0	Very fine silt	
		0.0020	2.0	9.0		
Pipette		0.00098	0.98	10.0	Clay	
		0.00049	0.49	11.0	(Some use 2ϕ or	
or		0.00024	0.24	12.0	9ϕ as the clay	
		0.00012	0.12	13.0	boundry)	
Hydrometer		0.00006	0.06	14.0		

APPENDIX 5.6

DEGREE OF SORTING AND GRAIN SHAPE CHART

Sorting		Grain Shape	
<u>Very Well</u>		<u>Angular</u>: having sharp corners and edges and, therefore, showing little or no effects of abrasion or wear.	
<u>Well</u>		<u>Subangular</u>: having edges and corners slightly rounded, so that wear is evident.	
<u>Moderately</u>		<u>Subround</u>: having most of the corners and edges worn down to smooth curves, thus, showing extensive abrasion.	
<u>Poorly</u>		<u>Round</u>: having all edges and corners smoothed off to gentle curves by prolonged wear.	

STANDARD OPERATING PROCEDURE 5.2

SOIL SAMPLING WITH A SPADE AND SCOOP

1. PURPOSE

To describe a method for collecting a soil sample less than four feet below the land surface.

2. DISCUSSION

The Remedial Investigation Plan (RIP) contains specific details about the procedures and equipment for this SOP. Refer to the RIP for the type of samples to be collected. Collection and measurement of samples and documentation of data will be performed as described in the associated procedures.

Sampling of the soil horizons above the groundwater table can detect contaminants before they migrate into the water table. Soil sample analysis can assist in determining the extent of the contaminant source term and establish the amount of contamination absorbed into aquifer solids that have the potential to contaminate groundwater.

The spade-and-scoop method can be used in most soil types, but is somewhat limited to sampling near the soil surface. Sample collection from depths greater than 50 inches can become extremely labor-intensive. Collection of samples from near the soil surface can be accomplished with tools like spades, shovels, and scoops. Spades and shovels will be used to remove surficial material to the required depth. Then a stainless steel or Teflon scoop is used to collect the sample. Devices plated with chrome or other materials are not acceptable for sample collection. The use of a flat, pointed mason trowel often aids in collecting undisturbed soil profile samples. To the extent possible, the sampling process should not alter the medium being investigated. Samples should be kept at their at-depth temperature or lower, protected from direct light, sealed tightly in glass bottles, and analyzed within the time allowed by the analytical method.

3. PROCEDURES

3.1. Associated Procedures

Before every operation, a review of the SOPs 1.1-1.10 is necessary. These SOPs contain information on the performance of field activities. They should be consulted for specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.3	Sample Control and Documentation

SOP No.	SOP Title
1.4	Sample Containers and Preservation
1.5	Guide to Handling, Packaging, and Shipping of Samples
1.6	General Equipment Decontamination
5.1	Soil and Rock Borehole Logging and Sampling

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all sampling equipment.

E. Notify the analytical laboratory of sample types, the number of samples, and the approximate arrival date.

F. Contact the carrier that will transport samples to obtain information on regulations and specifications.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

Decontaminate all sampling equipment before taking the first sample and between sampling intervals (see SOP 1.6, General Equipment Decontamination, and RIP).

3.3. Operation

A. Whenever a sample is collected, complete a description of the sample using the Borehole Log (Soil) form. Copies of this form and instructions for completing the form are supplied in SOP 5.1, Soil and Rock Borehole Logging and Sampling.

B. Procedure for Soil Sampling

1. Carefully remove the top layer of soil to the desired sample depth with a precleaned spade.

2. Using a precleaned, stainless steel or Teflon scoop or trowel, remove and discard a thin layer of soil from the area that comes in contact with the shovel.

3. Transfer the sample into an appropriate sample bottle with a stainless steel or Teflon scoop, lab spoon, or equivalent.

4. If required, be sure the Teflon liner is present in the cap. Secure the cap tightly. Preservation with chemical additives is not necessary; it is achieved by cooling the sample with ice. If feasible, minimize holding time and transport the sample to the laboratory no later than two days after collection.

5. Label the sample bottle with the appropriate sample tag. Be sure to label the tag carefully and clearly, addressing all the categories of parameters.

   NOTE: Whenever a sample is collected, a custody record must be initiated on the Custody Transfer Record/Lab Work Request form and a Soil Sample Identification Label affixed to the sample container. SOP 1.3, Sample Control and Documentation, contains copies of the form and label and instructions for completing the form and label.

6. Decontaminate equipment between sample locations according to SOP 1.6, General Equipment Decontamination.

7. Backfill the hole and replace any grass turf.

C. Procedures for Stream and Ditch Sediment Sampling.

1. Determine number of samples to be collected at each sampling station based on width of stream or ditch.

   If width is less than 5 ft, collect one sample from the center of the channel.

   If width is greater than or equal to 5 ft, but less than 10 ft, collect two samples from the third points along an imaginary line perpendicular to the direction of the flow.

   If width is greater than or equal to 10 ft, but less than 20 ft, collect three samples at the quarter points along the imaginary perpendicular line.

2. Wade to sampling point and push the BMH-53 bed-material sampler into the sediment about one foot (decontaminate sampler before use and between sampling points).

3. Place sample in containers.

4. If sample volume is not sufficient to fill the containers, continue to sample in an area approximately one square foot until sufficient sample is collected.

5. Seal sample containers and label.

6. Record time of sample collection.

7. Place sample in cooler with ice.

8. Repeat process at additional sampling sites as required.

9. Deliver samples to laboratory.

D. Procedures for pond sediment sampling.

1. Clean all equipment.

2. Ponds will be divided into sections and representative samples will be collected from each section.

3. Access sampling point using boat or raft.

4. Collect sample with a Coliwasa.

    Open sampler by placing stopper rod handle in the T-position and pushing rod down until handle sits against locking block.

    Slowly lower sampler into fluid.

    When the sampler hits bottom, push sampler tube into sediments.

    Lock the stopper by turning the T-handle upright so that one end rests on lock block.

    Withdraw Coliwasa from sediment and fluid.

5. If the sediment is too consolidated to be sampled with the Coliwasa, use a BMH-53 Bed-material sampler.

6. Place sample in containers.

7. If sample volume is insufficient to fill containers, repeat sampling process in vicinity of sampling location until sufficient volume is collected.

8. Label sample containers and record time of sample collection.

9. Place samples in cooler with ice.

10. Decontaminate equipment and move to next sampling point.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. Restore the site to presampling conditions and fill open sampling holes as specified in the RIP.

C. Make sure all sampling locations are properly staked and the location ID is readily visible on the location stake.

D. Prepare samples and transport according to SOP 1.3, Sample Control and Documentation; SOP 1.4, Sample Containers and Preservation; and SOP 1.5, Guide to Handling, Packaging, and Shipping of Samples.

3.4.2. Documentation

A. Record pertinent sample location information in the logbook.

B. Record cleanup and hole abandonment procedures and any uncompleted work (like site restoration or long-term monitoring) in the logbook.

C. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

D. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the site manager for technical review. He/she will review, sign forms, and transmit to the document control officer (copies to the files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Contact the analytical laboratory to ensure that the samples arrived safely and the instructions for sample analyses are clearly understood.

4. SOURCE

Ford, Patrick J., Paul J. Turina, and Douglas E. Seely. 1984. Available Sampling Methods, 2d ed. Vol. 2, Characterization of Hazardous Waste Sites - A Methods Manual. U.S. Environmental Protection Agency document EPA/600/4-84/076. Washington, D.C.: U.S. Government Printing Office.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Sediment Sampling Form

5.3. Data Form Completion

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

_________ Stainless steel scoop or lab spoon (scoopulas)

_________ Stainless steel shovel or fat-pointed mason trowel

_________ Stainless steel spade

_________ Tape measure (tenths)

_________ Teflon sheets or stainless steel sampling trays

_________ Plastic Sheet

_________ Alconox

_________ Brushes (long handle, scrub, and wire)

_________ Galvanized tub

_________ Trash bags

_________ Buckets (galvanized, stainless steel, and plastic)

_________ Garden pressure sprayer

_________ Cleaning wipes

_________ Kim wipes

_________ Storage containers for waste decontamination solutions

_________ Blue Ice or equivalent

_________ Disposable laboratory gloves

_________ Camera and film

_________ Sample containers and preservatives

_________ Any additional supplies listed in associated procedures, as needed

APPENDIX 5.2

SEDIMENT SAMPLING SHEET

STATION NO.: ____________________

SEDIMENT SAMPLING SHEET

QA Review by/Date: ____________________

Location: ____________________ Time: ____________________

____________________ W.O.#: ____________________

____________________ Weather: ____________________

____

Personnel: ____________________

____________________ Date: ____________________

Sample Method: ____________________

Lithologic Description: ____________________

____

____

Sample No.	Container Type/Volume	Parameter	Time Collected

HNu Readings Model: __________ with __________ ev Probe

Background: ____________________ Sample: ____________________

APPENDIX 5.3

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

SEDIMENT SAMPLING SHEET

1. Station No. Designated Station ID Number

2. QA Review By/Date. Signature of person performing QA of the form followed by the date the QA was completed.

3. Location. Facility name and specific area within the facility that the station is located.

4. Personnel. Sampling crew members.

5. Sample Method. Method used to obtain the sample.

6. Time. Military time the personnel arrived at the station.

7. W.O.#. Work order or job number.

8. Weather. Weather conditions at the time of sampling.

9. Date. Date the sample was collected.

10. Lithologic Description. Description of the sampling including major constituents, color, grain size, sorting, moisture content, etc.

11. Sample Information.

    A. Sample No. Sample ID designation.

    B. Container Type/Volume. Type of sample container (plastic, glass, etc.)/volume of sample container.

    C. Parameter. Analyses requested from the laboratory.

    D. Time Collected. Military time that each sample container was filled.

12. HNU Readings.

Model. Photoionization detector model number and probe size.

Background. Reading taken in breathing zone.

Sample. Reading taken in sample media

STANDARD OPERATING PROCEDURE 6.1

HEALTH AND SAFETY MONITORING OF COMBUSTIBLE GAS LEVELS

1. PURPOSE

To describe the equipment and proper method for monitoring combustible gas levels in order to determine when an explosion hazard exists in the work environment.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information on the scope of specific operations, related health and safety requirements, and the applicability of this procedure. Combustible gas indicators (or explosimeters) are used to determine the potential for the combustion or explosion of unknown atmospheres. A typical combustible gas indicator (CGI) determines the level of organic vapors and gases present in an atmosphere as a percentage of the lower explosive limit (LEL) or lower flammability limit (LFL) by measuring the change in electrical resistance in a Wheatstone bridge circuit.

CGIs provide readouts in units of percent LEL, in parts per million (ppm) combustible gases by volume, or both. The types of combustible gases to be encountered are often unknown. In those instances, the more explosive the calibration gas (the lower the LEL), the more sensitive the indication of explosivity, and a greater margin of safety results. The operator should be familiar with the LEL concentrations for specific gases to effectively use instruments that provide data only in ppm combustible gas (by volume).

Although instruments can be purchased that are factory-calibrated for gases like butane, pentane, natural gas, or petroleum vapors, methane calibration is the most common. The LEL of methane is 5% by volume in air; therefore, an air mixture containing 5% methane will be read as 100% LEL and is explosive. When combustible gases other than methane are sampled, the relative response of the detector must be considered. Recalibration to other gases may be possible (see the manufacturer's recommendations), and National Bureau of Standards (NBS) traceable calibration gases should be used. The relative sensitivity of the detector and the differences in LEL for different gases will produce varying meter responses. Correlation equations that will convert the percent LEL (based on methane) indicated by the instrument to a percent LEL for another combustible gas can usually be found in the CGI operating manual. Many units have alarm systems that can be adjusted for various LELs, and several incorporate oxygen analyzers.

2.1. Definitions

A. Lower Explosive Limit (LEL)

The LEL (also LFL, lower flammability limit) is defined as the lowest concentration of gas or vapor in air by volume that can be ignited and cause an explosion or flame propagation.

B. Upper Explosive Limit (UEL)

The UEL (also UFL, upper flammability limit) is the concentration of gas in air above which there is insufficient oxygen available to support combustion and an explosion is unlikely. A flame, however, may burn at the gas/air interface. Should additional air enter the mixture, a very explosive atmosphere may develop.

2.2. Instrument Limitations

A. Of the many instruments commercially available for detecting combustible or explosive gas, some are not certified safe for operation in the atmospheres they can detect. It is important to use only those instruments that are certified safe for use in atmospheres greater than 25% of the LEL. The instrument manufacturer's operating manual should be consulted to determine safety certification in specific atmospheres.

B. Combustible gas measurement instruments do not indicate if a given atmosphere contains hazardous or toxic compounds.

C. The CGI cannot be used in atmospheres containing silanes, silicones, silicates, or other compounds containing silicon because these substances seriously impair the instrument response.

D. If the detector has a platinum filament, its sensitivity may be reduced by exposure to gases like leaded gasoline vapors (tetraethyl lead), sulfur compounds (mercaptans and hydrogen sulfide), and sulfide compounds. An inhibitor filament that will nullify the effect of leaded gasoline vapors is available on some commercial units (Mine Safety Appliances Company, Model 260 Portable Combustible Gas and Oxygen Alarm). The instrument manufacturer's operating manual should be consulted to determine the instrument's ability to function in leaded gasoline atmospheres.

E. An oxygen detector should be used in conjunction with a CGI. Select a unit with this feature and follow the operating manual when the oxygen detector is calibrated and used. This is especially important when atmospheres are monitored within enclosed spaces or where oxygen deficient atmospheres (<19.5%) may exist.

F. Unusually high concentrations of sulfur dioxide, fluorine, chlorine, bromine, iodine, and oxides of nitrogen cause measurement interference.

G. Combustible gas indicator instruments must be calibrated frequently. Using an NBS traceable calibration gas, consult the manufacturer's operating manual for calibration frequency. Also, frequent calibration will be necessary if several known organic species are present. Maximum accuracy requires a recalibration for each gas.

3. PROCEDURE

3.1. Associated Procedures

Information that applies to most field activities is provided in SOPs 1.1-1.10. In addition to the RIP, those SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Perform a minimal check of the CGI in the office to ensure that it is functioning properly. Obtain the CGI, its operating manual, and a supply of NBS traceable gas. Methane is the factory calibration gas, but other gaes may be used for specific requirements. Perform the equipment checks described below.

1. Make sure the instrument is clean and serviceable, especially sample lines and detector surfaces.

2. Check the battery charge level. If in doubt, charge the battery as described in the operating manual. Some units have charge level meters, while others have only low charge alarms.

3. Turn the unit to the on position and allow the instrument sufficient warmup time.

4. Verify that the sample pump is operable when the analyzer is on. The pump can usually be heard when operating.

5. With the intake assembly in combustible gas-free ambient air, zero the meter by rotating the zero control until the meter reads 0% LEL. For instruments with an additional oxygen meter, adjust the dial to 21% oxygen in nonhazardous locations.

6. Calibrate the unit against a known concentration of a calibration gas like hexane by rotating the calibration control (span or gain) until the meter reads the same concentration as the known standard.

7. Some instruments, like the Gas Tech Model 1314, require internal calibrating with a small screwdriver. Consult the operating manual before calibration. With this model, it is also necessary to maintain the proper flow rate during calibration. Connect a flow meter between the CGI and the calibration gas cylinder to monitor the flow rate.

8. The Gas Tech Model 1314 and others are equipped with three meters that read in percent O_2, percent LEL, and ppm. A correctly calibrated instrument for determining percent LEL is critical for monitoring many work environments. The percent oxygen is usually factory calibrated and should not be adjusted in the field. The ppm dial is often not used in the field unless a Photoionization Detector (PID) or Flame Ionization Detector (FID) is not available, as these instruments are considered to be more accurate.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Instrument Check

Before using the CGI in the field, follow the procedures in Section 3.2.1.D. Additional adjustments may be made. If necessary, adjust the alarm setting to the appropriate combustibility limit. The action level or the point at which activities are halted and personnel removed from the immediate vicinity is usually less than 25% of the LEL for the gases that are present.

B. Record necessary calibration data in the logbook and include the information listed below.

1. Date and time of arrival at the site

2. Site identification

3. Instrument, model number, and serial number

4. Date/time calibrated

5. Calibration gas used

6. Calibration location

7. Operator's signature

3.3. Operation

3.3.1. Field Measurements

A. Calibrate the CGI daily before use in the field. The calibration procedure for the Gas Tech Model 1314 is outlined in Appendix 5.4. Also, consult the manufacturer's manual.

B. Complete the Combustible Gas Indicator Monitoring Data form (Appendix 5.2) as described in Appendix 5.3, Data Form Completion.

C. Position the intake assembly close to the area in question to get an accurate reading. For readings taken downhole during drilling, there will be a slight delay between positioning the intake tubing downhole and registering accurate meter readings because of the time required for the sample to travel the length of the tube.

D. In general, combustible gas indicator instruments respond in the manner described below.

   1. The meter indicates 0.5 LEL (50%). This means that 50% of the concentration of combustible gas needed to reach an unstable combustible situation is present. If the LEL of the gas is 5% in air, then the instrument indicates the presence of a 2.5% mixture.

   2. The meter needle stays above 1.0 LEL (100%). This means that the concentration of combustible gas is greater than the LEL and less than the UEL. Therefore, the concentration is immediately combustible and explosive.

   3. The meter needle rises above the 1.0 (100%) mark and then returns to zero. This response indicates that the ambient atmosphere has a combustible gas concentration greater than the UEL.

E. Personnel should evacuate the area if any of the events listed below occur.

   1. Sounding of the alarm

   2. Readings that reach the action levels designated in the Health and Safety Plan

   3. Malfunctioning of the CGI

   4. Condition encountered or suspected that indicates oxygen enrichment or depletion of the atmosphere (specially designed units are available for operation in those atmospheres)

F. Some important factors to keep in mind during use are listed below.

1. Slow, sweeping motions of intake or cell assembly will help ensure that problem atmospheres are not bypassed. Cover an area from floor (ground) to ceiling, the breathing zone, and areas where maximum concentrations may be expected (for example, downhole during drilling).

2. Operation of the unit in temperatures outside the recommended operating range may compromise the accuracy of readings or damage the instrument. Check the operating manual for the temperature limitations of a particular model.

3. Many combustible gas indicators are not designed for use in oxygen-enriched or depleted atmospheres. If this condition is encountered or suspected, personnel should evacuate the area. Specially designed units are available for operation in those atmospheres.

4. Use an oxygen detector in conjunction with a CGI. Select a unit and follow the operating manual for calibration and use of the oxygen detector.

5. Calibrate the equipment regularly and charge the battery after each field use. See the operating manual for details.

6. The operator should fully understand the operating principles and procedures for the specific CGI in use.

3.4 Postoperation

3.4.1 Field

A. When the activity is completed or at the end of the day, carefully clean the outside of the CGI with a damp disposable towel to remove any visible dirt. Return the CGI to a secure area and place on charge.

B. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

C. Make sure all survey or sampling locations are properly staked and the location ID is readily visible on the location stake.

3.4.2. Documentation

A. Record any uncompleted work (like additional monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the document control officer (with copies to the site manager and files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCE

EPA. 1984. "Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods, Second Edition," U.S. Environmental Protection Agency report EPA-600/4-84-076. Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, Nevada.

5.. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Combustible Gas Indicator Monitoring Data Form

5.3. Data Form Completion

5.4. Calibration Procedure for Gas Tech Model 1314

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

________ CGI

________ Battery charger for CGI

________ Oxygen sensor

________ Battery charger for oxygen sensor

________ Spare gas detector filaments

________ Spare batteries for CGI

________ Jeweler's screwdrivers for internal adjustment

________ Calibration kit

A) Spare gas cylinder (NBS traceable calibration gas)
B) Valve attachment
C) Flexible tubing (tygon)
D) Cylinder to encapsulate sensor probe

________ Probe extensions

COMBUSTIBLE GAS INDICATOR MONITORING DATA FORM

COMBUSTIBLE GAS INDICATOR (CGI) MONITORING DATA

FACILITY CODE ____________________ LOG DATE ____________________

LOGGER CODE ____________________ FIELD REP ____________________

CGI MANUFACTURER ____________________ CGI MODEL NO ____________________

SERIAL NO ____________________ CALIBRATION DATE/TIME ____________________

ACCEPTANCE CODE ____________________ BATTERY CONDITION ____________________

CALIBRATION
GAS (%LEL):
TYPE ______________ CONCENTRATION ________ % LEL CYLINDER SERIAL NO ____________

CALIBRATION
GAS (PPM):
TYPE ______________ CONCENTRATION ________ PPM CYLINDER SERIAL NO ____________

COMMENTS ____

____

____

LOCATION ID OR DESCRIPTION	COORDINATES (FT)		MONITORING TIME (HH:MM)	LOCATION TYPE	% LOWER EXPLOSIVE LIMIT	PPM	% OXYGEN
	NORTH	EAST					

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

LOCATION TYPES: BH - BOREHOLE SL - SURFACE LOCATION TP - TEST PIT WL - WELL

COMPLETE BOLDED DATA FOR ENTRY INTO TMS

CB-101 (1/88)

____________________ FORM COMPLETED BY/DATE

____________________ TECHNICAL REVIEWER/DATE

APPENDIX 5.3

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

COMBUSTIBLE GAS INDICATOR MONITORING DATA FORM

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date the information recorded on the form was obtained, in the format DD-MMM-YY (01-JAN-88).

3. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

4. Field Rep. The name of the field representative.

5. CGI Manufacturer. The company that manufactured the CGI.

6. CGI Model No. The model number of the CGI.

7. CGI Serial No. The serial number of the CGI.

8. CGI Calibration Date/Time. The date and time when the CGI was last calibrated.

9. Acceptance Code. One-character code assigned by the site manager.

10. Battery Condition. The battery charge reading at the beginning of the measurement.

11. Calibration Gas (% LEL). This information consists of three data fields: the chemical name of the calibration gas (type), concentration of the calibration gas (% LEL), and the serial number of the gas cylinder.

12. Calibration Gas (ppm). This information consists of three data fields: the chemical name of the calibration gas (type), concentration of the calibration gas (ppm), and the serial number of the gas cylinder.

13. Comments. Any additional information.

14. Location ID or Description. Four-character code assigned sequentially to each borehole, test pit, or surface location where physical, chemical, biological, radiological, and other measurements are taken.

15. Coordinates (Ft). The location of the measurement of the survey grid in units of feet. The two coordinate fields are in the format north, east.

16. Monitoring Time (HH:MM). The time when a field measurement was taken in the format hours:minutes using a 24-hr clock. Example: 08:37 for 8:37 a.m. and 19:12 for 7:12 p.m. (See conversion table below.)

Conversion Table

Conventional Time	24-Hr Time
1:00 a.m.	1:00
12:00 Noon	12:00
1:00 p.m.	13:00
2:00 p.m.	14:00
3:00 p.m.	15:00
4:00 p.m.	16:00
5:00 p.m.	17:00
6:00 p.m.	18:00
7:00 p.m.	19:00
8:00 p.m.	20:00
9:00 p.m.	21:00
10:00 p.m.	22:00
11:00 p.m.	23:00
12:00 Midnight	24:00

17. Location Type. Code describing the location of the CGI reading. The location type codes are: BH--borehole, TP--test pit, SL--surface location, and WL--well.

18. Percent Lower Explosive Limit. The reading obtained with the meter set to the LEL Scale.

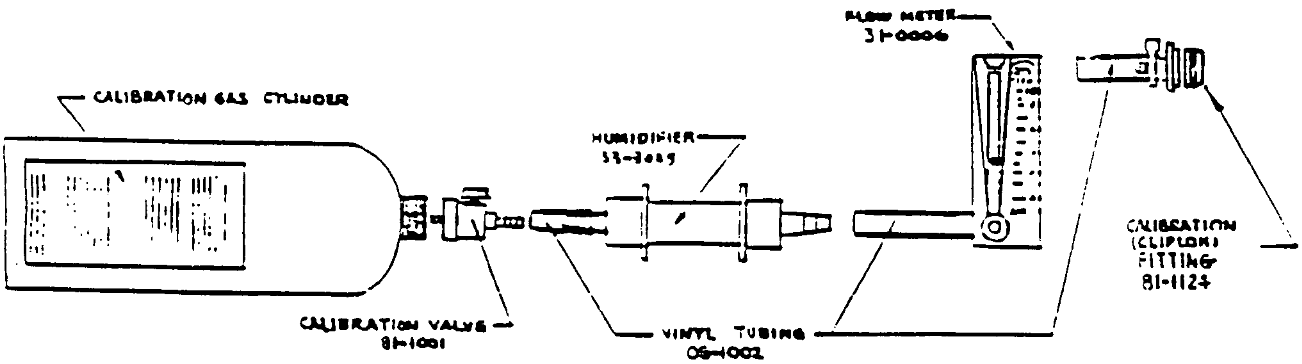
19. PPM. The reading with the meter set to the PPM scale.

20. Percent Oxygen. Record the percent oxygen reading in this data field.

APPENDIX 5.4

CALIBRATION PROCEDURE FOR GAS TECH MODEL 1314

GASTECH MODEL 1314 CALIBRATION



CALIBRATION PROCEDURE

1. PPM RANGE
   - 1.01 Turn on instrument, allow to warm up and adjust zero in normal way.
   - 1.02 Add a few drops of water to glass wool packing inside humidifier. Glass wool should be moist but not dripping.
   - 1.03 Couple flowmeter to Cliplok fitting, and humidifier to flowmeter inlet, as shown.
   - 1.04 Couple Cliplok fitting to instrument inlet.
   - 1.05 Readjust zero as required after instrument stabilizes.
   - 1.06 Note flowmeter reading.
   - 1.07 Connect calibration valve to ppm—range cylinder. Open valve slightly to produce a small flow.
   - 1.08 Couple valve outlet to humidifier inlet.
   - 1.09 Adjust valve to give same flow on flowmeter as observed in 1.06.
   - 1.10 Watch meter as gas enters instrument. Observe highest reading.
   - 1.11 Compare reading with marked gas concentration on cylinder.
   - 1.12 If not correct, adjust calibration as shown in Section V of Instruction Manual.
   - 1.13 Turn off valve and disconnect calibration components.
2. LEL Range

   Use same procedure as above, but in LEL range. However, omit humidifier as it is not necessary in LEL range. Use LEL range cylinder.

GED-138 (1/88)

STANDARD OPERATING PROCEDURE 6.2

HEALTH AND SAFETY MONITORING OF ORGANIC VAPORS WITH A PHOTOIONIZATION DETECTOR

1. PURPOSE

To describe the equipment and proper method for environmental monitoring of toxic gases and vapors using a portable photoionization detector (PID).

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information on the scope of the given operation and the applicability of this procedure to the work activities.

The PID is useful as a general survey instrument at hazardous waste sites. A PID is capable of detecting and measuring real-time concentrations of many organic and inorganic vapors in the air. A PID is similar to a flame ionization detector (FID) in application. The PID has somewhat broader capabilities because it can detect certain inorganic vapors. Conversely, the PID is unable to respond to certain low molecular weight hydrocarbons (like methane and ethane) that are readily detected by FID instruments. Appendix 5.1 describes the application comparisons between an FID organic vapor analyzer and a PID.

A PID will respond to most vapors that have an ionization potential less than or equal to that supplied by the ionizing source in the detector, which is an ultraviolet (UV) lamp. Several probes are available for the PID, each having a different source and a different ionization potential. For this reason, the selection of the appropriate probe is essential in obtaining useful field results. Though it can be calibrated to a particular compound, the instrument cannot distinguish between detectable compounds in a mixture of gases. Therefore, it indicates an integrated response to the mixture.

2.1. PID Instrument Limitations

A. The PID is a nonspecific total vapor detector. It cannot be used to identify unknown substances; it can only quantify them.

B. The PID must be calibrated to a specific compound.

C. The PID does not respond to certain low molecular weight hydrocarbons like methane and ethane.

D. Certain toxic gases and vapors like carbon tetrachloride and hydrogen cyanide have high ionization potentials and cannot be detected with a PID.

E. Certain models of PID instruments are not intrinsically safe. Refer to the manufacturer's operating manual for use in potentially flammable or combustible atmospheres. A PID should be used in conjunction with a combustible gas indicator (see SOP 6.1, Health and Safety Monitoring of Combustible Gas Levels).

F. Electrical power lines or power transformers close to the PID instrument may cause measurement errors. Under this circumstance, refer to the operating manual for proper procedures.

G. High winds and high humidity will affect measurement readings. Certain models of PID instruments become unusable under foggy conditions. An indication of this is the needle dropping below 0.

H. The lamp window must be periodically cleaned to ensure ionization of the air contaminants.

I. One PID instrument, the HNu, measures concentrations from about 1 to 2000 ppm, although the response is not linear over this entire range. For example, the response to benzene is linear from about 0 to 600 ppm. This means the HNu reads a true concentration of benzene only between 0 and 600. Greater concentrations are read at a lower level than the true value. Consult the manufacturer's operating manual to determine the instrument's response to various chemicals.

2.2. Regulatory Limitations

A. Transport of calibration gas cylinders by passenger and cargo aircraft follow the U.S. Code of Federal Regulations, 49 CFR Parts 100-177. Isobutylene is a typical calibration gas included with a PID. Isobutylene is classified as a nonflammable gas, UN 1556, and the proper shipping name is compressed gas. It must be shipped in cargo aircraft only.

3. PROCEDURE

3.1. Associated Procedures

Information that applies to most field activities is provided in SOPs 1.1-1.10. In addition to the RIP, those SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
6.1	Health and Safety Monitoring of Combustible Gas Levels

3.2. Preparation

3.2.1 Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.2. Perform the procedures described below.

1. Start-Up Procedure

a. Before attaching the probe, check the function switch on the control panel to ensure that it is in the off position. Attach the probe by plugging it into the interface on the top of the readout module. Use care in aligning the prongs in the probe cord with the plug interface. Do not use excessive force.

b. Turn the function switch to the battery check position. The needle on the meter should be within or above the green battery arc on the scale; if not, recharge the battery. If the red indicator light comes on, the battery needs recharging.

c. Turn the function switch to any range setting. Look into the end of the probe to see if the lamp is on. If it is on, it will emit a purple glow. Do not stare into the probe any longer than 3 sec. Long-term exposure to UV light will damage the eyes. Also, listen for the hum of the fan motor.

d. To zero the instrument, turn the function switch to the standby position and rotate the zero adjustment until the meter reads zero. A calibration gas is not needed because this is an electronic zero adjustment. If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted (if necessary). Wait 15 to 20 sec to ensure that the zero reading is stable. If necessary, readjust the zero.

2. Operational Check

a. Follow the start-up procedure.

b. With the instrument set on the 0 to 20 range, hold a solvent-based marker pen near the probe tip. If the meter deflects upscale, the instrument is working.

3. Calibration Procedure

a. Follow the start-up procedure and the operational check.

b. Set the function switch to the range setting for the concentration of the calibration gas.

c. Remove the detector from the outer casing by loosening the screw on the bottom of the casing.

d. Attach a regulator to a disposable cylinder of calibration gas. Connect the regulator to the probe of the PID with a piece of clean tygon tubing. Open the valve on the regulator.

e. After 15 sec, adjust the internal calibration screw until the meter reading equals the concentration of the calibration gas used. Consult the operating manual for the location of this screw.

f. If the PID does not start up, check out or calibrate properly and notify the equipment manager immediately. Under no circumstances should work requiring monitoring with a PID be performed without a properly functioning instrument.

g. Replace the detector in the outer casing.

h. Contact the carrier that will transport equipment and hazardous materials to obtain information on regulations and specifications.

3.2.2. <u>Documentation</u>

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

E. Record the calibration data on the Photoionization Detector Field Data form (Appendix 5.3). See Appendix 5.4 (Data Form Completion) for instructions.

3.2.3. <u>Field</u>

A. Follow the start-up procedure, operational check, and calibration check described in Section 3.2.1.D.

B. Set the function switch to the appropriate range. If the concentration of gases or vapors is unknown, set the function switch to the 0 to 20 ppm range; adjust the range if necessary.

C. With the exception of the probe's inlet and exhaust, wrap the PID in clear plastic to prevent it from becoming contaminated and to prevent water from getting inside the instrument in the event of precipitation.

3.3. Operation

3.3.1 Measuring organic vapor levels using the PID

A. As with any field instrument, accurate results depend on the operator's knowledge of the operator's manual. Follow the instructions in the operating manual explicitly in order to obtain accurate results.

B. Position the intake assembly close to the monitoring area because the low sampling rate allows for only very localized readings. Do not immerse the intake assembly in fluid under any circumstances.

C. While taking care not to permit the PID to be exposed to excessive moisture, dirt, or contamination, monitor the work activity as specified in the site Health and Safety Plan. Conduct the PID survey at a slow to moderate rate of speed and slowly sweep the intake assembly (the probe) from side to side.

D. During drilling activities, perform PID monitoring at every 5-ft interval downhole, at the headspace, and in the breathing zone. In addition, monitoring may be performed in the breathing zone during actual drilling when elevated organic vapor levels are encountered. When the activity being monitored does not involve drilling (like surface sampling), readings may only be recorded in the breathing zone. Refer to the site Health and Safety Plan for specific monitoring instructions.

E. Be prepared to evacuate the area if the preset alarm sounds. Operators using supplied air systems may not need to evacuate the work area, but they should frequently observe the levels indicated by the instrument.

F. Static voltage sources like power lines, radio transmissions, or transformers may interfere with measurements. See the operator's manual for a discussion of necessary considerations.

3.4. Postoperation

3.4.1. Field

A. When the activity is completed or at the end of the day, carefully clean the outside of the PID with a damp disposable towel to remove any visible dirt. Return the PID to a secure area and place on charge.

B. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

C. Make sure all survey or sampling locations are properly staked and the location ID is readily visible on the location stake.

3.4.2. Documentation

A. Record any uncompleted work (like additional monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the document control officer (with copies to the site manager and files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment and charge the batteries. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCES

HNU Systems, Inc. 1986. "Instruction Manual for the Trace Gas Analyzer Model PI 101." Newton, Massachusetts.

CFR 49. 1985. Code of Federal Regulations, Title 49, U.S. Department of Transporatation, Parts 100-177. November 1, 1985. Washington, D.C.: U.S. Government Printing Office.

EPA. 1984. "Characterization of Hazardous Waste Sites--A Methods Manual: Volume II. Available Sampling Methods, Second Edition" U.S. Environmental Protection Agency report EPA-600/4-84-076. Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, Nevada.

5. APPENDICES

5.1. Comparison of the FID and PID

5.2. Equipment and Supplies Checklist

5.3. Photoionization Detector Field Data Form

5.4. Data Form Completion

APPENDIX 5.1

COMPARISON OF THE FID AND PID

	FID	PID
Response	Responds to many organic gases and vapors, especially low molecular weight hydrocarbons.	Responds to many organic and some inorganic gases and vapors, especially heavy hydrocarbons.
Application	In survey mode, detects total concentrations of gases and vapors. In GC mode, identifies and measures specific compounds.	In survey mode, detects total concentrations of gases and vapors. Some identification of compounds possible if GC column and standards are used.
Limitations	Does not respond to inorganic gases and vapors with a higher ionization potential than the flame detector. No temperature control.	Does not respond to methane or inorganic aliphatic chlorinated solvents. Does not respond properly in presence of water vapor (high humidity). Does not detect a compound if probe (lamp) has a lower energy than compound's ionization potential.
Calibration gas	Methane and others	Benzene (1,3-butadiene) and others
Ease of operation	Requires experience to interpret correctly, especially in GC mode.	Fairly easy to use and interpret. More difficult in the GC mode.
Detection limits	0.1 ppm (methane)	0.1 ppm (benzene), depends on lamp voltage.
Response time	2-3 sec (survey mode)	3 sec for 90% of total concentration

APPENDIX 5.1, Concluded

	FID	PID
Maintenance	Periodically clean and inspect particle filters, valve rings, and burner chamber. Check calibration and pumping system for leaks. Recharge battery after each use.	Clean UV lamp frequently. Check calibration regularly. Recharge battery after each use.
Useful range	0-1000 ppm	0-2000 ppm
Service life	8 hrs; 3 hrs with strip chart recorder	10 hrs; 5 hrs with strip chart recorder

APPENDIX 5.2

EQUIPMENT AND SUPPLIES CHECKLIST

_________ Photoionization detector (PID)

_________ Operating manual

_________ Probes: 9.5eV______, 10.2eV______, and 11.7eV______

_________ Battery charger for PID

_________ Spare batteries

_________ Jeweler's screwdriver for adjustments

_________ Tygon tubing

_________ NBS traceable calibration gas (type)__________

_________ "T" valve for calibration

_________ Intake assembly extension

_________ Strap for carrying PID

_________ Teflon tubing for downhole measurements

_________ Plastic bags for protecting the PID from moisture and dirt

APPENDIX 5.3

PHOTOIONIZATION DETECTOR FIELD DATA FORM

PHOTOIONIZATION DETECTOR FIELD DATA

FACILITY CODE ____________________ LOG DATE ____________________

LOCATION ID ____________________ LOCATION TYPE ____________________

LOGGER CODE ____________________ FIELD REP ____________________

PHOTOIONZATION DETECTOR INSTRUMENT: MODEL ____________________

MANUFACTURER ____________________ DATE/TIME CALIBRATED ____________________

SERIAL NO ____________________ ACCEPTANCE CODE ____________________

CALIBRATION GASES:	
TYPE/CYLINDER ID NO	CONCENTRATION (PPM)/SPAN
1	1
2	2

COMMENTS ____________________

TIME (HH:MM)	SAMPLE ID	OBSERVED READING (ppm)					DRILLING DEPTH (FT)	COMMENTS
		DH	HS	BZ	D	OT		

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

LOCATION TYPES:
BH - BOREHOLE
SS - SOIL SAMPLE
SL - SURFACE LOCATION
SB - SAMPLE BOTTLE
TP - TEST PIT
WL - WELL
OT - OTHER

OBSERVED READING: D - DURING DRILLING (BZ)
DH - DOWNHOLE
HS - HEADSPACE
BZ - BREATHING ZONE
OT - OTHER

COMPLETE BOLDED DATA FOR ENTRY INTO THIS
PHD-040 (1/89)

____________________ FORM COMPLETED BY/DATE

____________________ TECHNICAL REVIEWER/DATE

APPENDIX 5.4

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

PHOTOIONIZATION DETECTOR FIELD DATA FORM

1. Facility Code. Five-character code abbreviating the facility name where the program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

3. Location ID. Four-character code assigned sequentially to each borehole, test pit, or surface location where physical, chemical, biological, radiological, and other measurements are taken.

4. Location Type. Two-character code identifying where the sample was taken. There is one location type for each location ID. Location types include those listed below.

   BH--Borehole

   TP--Test Pit

   SL--Surface Location

   WL--Well

   SB--Sample Bottle

   SS--Soil Sample

   OT--Other (explain)

5. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information on the form.

6. Field Rep. The name of the field representative.

7. PID Model. Model of photoionization detector (PID) instrument.

8. PID Manufacturer. Manufacturer's name on the PID instrument used.

9. Date/Time Calibrated. Last day and time when the PID instrument was calibrated. Calibration should be performed daily.

10. Serial No. Serial No. of PID instrument.

11. Acceptance Code. One-character code assigned by the site manager.

12. Calibration Gases

    a) Type/Cylinder ID No. Name of the calibration gas and the identification number of the cylinder.

    b) Concentration (ppm)/span. Concentration of calibration gas in parts per million (ppm) and the span setting for calibration.

13. Comments. Any additional information.

14. Time (HH:MM). The time when a field measurement was taken in the 24-hr clock format of hours:minutes (for example, 08:37 for 8:37 a.m. and 19:12 for 7:12 p.m.). See the conversion table below.

Conversion Table

Conventional Time	24-Hr Time
1:00 a.m.	1:00
12:00 Noon	12:00
1:00 p.m.	13:00
2:00 p.m.	14:00
3:00 p.m.	15:00
4:00 p.m.	16:00
5:00 p.m.	17:00
6:00 p.m.	18:00
7:00 p.m.	19:00
8:00 p.m.	20:00
9:00 p.m.	21:00
10:00 p.m.	22:00
11:00 p.m.	23:00
12:00 Midnight	24:00

15. Sample ID. When samples are being taken during a PID monitoring, the identification number or code assigned to a particular sample (like 01) is correlated with the observed readings and appropriate drilling depth (if drilling is being performed). This is useful in selecting samples for analyses and in the correlation of laboratory data with PID measurements.

16. Observed Reading (ppm). PID reading at the respective location ID in the units indicated on the meter. When the calibration gas and the gas being measured for the environment are the same, the meter reads in parts per million (ppm) during drilling. Readings may be taken downhole, at the headspace, and in the breathing zone, and data should be recorded in the appropriately marked column.

17. Drilling Depth (Ft). PID monitoring is performed every 5 ft during drilling. The depth of the drilling is listed in feet and can be given as the most recent interval (like 5-10) or as the ending depth (like 10).

18. Comments. Any additional information, including the type of gas being measured if this determination can be made (for example, by labels on drums).

STANDARD OPERATING PROCEDURE 6.3

HEALTH AND SAFETY MONITORING OF ORGANIC VAPORS WITH A FLAME IONIZATION DETECTOR

1. PURPOSE

To describe the equipment and proper method for environmental monitoring of toxic gases and vapors using a portable flame ionization detector (FID).

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information on the scope of the given operation and the applicability of this procedure to the work activities.

An FID is useful as a general screening tool to detect the presence of most organic vapors. It can be used to detect pockets of gaseous hydrocarbons in depressions or confined spaces, to screen drums or other containers for the presence of trapped vapors, or to screen an area for the presence of elevated levels of vapor-phase organics.

The FID is similar to a photoionization detector (PID) in application, but cannot detect certain inorganic vapors that are detected by the PID. However, the PID is unable to respond to certain low molecular weight hydrocarbons (like methane and ethane) that are readily detected by FID instruments. Appendix 5.1 describes the application comparisons between an FID organic vapor analyzer and a PID.

The FID will respond to most organic vapors as they form positively charged ions when burned in a hydrogen flame. The magnitude of the response is a function of the detector sensitivity and the ionization properties of the particular compound, as well as its concentration. As a result, the response must be compared with the response generated by a known concentration of a standard gas. The sample concentration is then reported as the parts-per-million (ppm) equivalent of the standard gas. Most units are calibrated with methane; however, almost any gaseous hydrocarbon that produces a response can be used. Many models also have built-in calibration circuits to ensure that the electronic response remains constant in all ranges.

2.1. FID Instrument Limitations

A. The FID does not respond to nongaseous organic compounds like some pesticides, polynuclear aromatic hydrocarbons (PNAs), and polychlorinated biphenyls (PCBs).

B. Most portable FIDs rely on the sample gas to supply the combustion air to the detector flame, so they are designed to operate in ambient atmospheres with oxygen concentrations of approximately 21%. This design precludes the sampling of process vents, poorly ventilated or sealed containers, or any sample gas hydrocarbon concentration sufficient to reduce the available oxygen or saturate the detector. Optional equipment is available that supplies oxygen from a compressed gas bottle or introduces sample gas through a dilution system with a known dilution factor.

C. Concentrations beyond the greatest scale factor of the instrument or in excess of 30% of the lower explosive limit (LEL) of the sample component require system modification. If system modifications are required, consult the manufacturer's operating manual.

D. Certain FID instruments have negligible response to carbon monoxide (CO) and carbon dioxide (CO_2). Their structure precludes the production of appreciable ions in the detector flame so other organic materials may be analyzed in the presence of CO and CO_2.

E. As with the PID, the FID responds differently to different compounds. Appendix 5.2 contains a list of the relative sensitivities of one FID model to some common organic compounds. Because the instrument is factory calibrated to methane, all relative responses are given in percentages with methane at 100. Therefore, the identity of the chemical of interest must be ascertained before its concentration can be determined. In addition, the unit requires a trained individual to maintain and operate the unit.

2.2. Regulatory Limitations

A. Department of Transportation regulations (DOT-E-7607) prohibit the carrying of compressed hydrogen gas on passenger aircraft. When the FID instrument is transported on a passenger aircraft, the hydrogen gas contained in the instrument must be emptied before loading.

B. Transport of an FID or extra cylinders of hydrogen gas or calibration gas by cargo aircraft must comply with the regulations stipulated in 49 CFR, Parts 100-177.

C. Appendix 5.6 describes the procedure for transporting an FID with a hydrogen tank. Consult the shipper for any recent changes in this procedure.

3. PROCEDURE

3.1. Associated Procedures

Information that applies to most field activities is provided in SOPs 1.1-1.10. In addition to the RIP, those SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Contact the carrier that will transport samples to obtain information on regulations and specifications.

E. Assemble the equipment and supplies listed in Appendix 5.3. Perform the functional checks described below. The purpose of these checks is to verify that an instrument will function properly (for example, the batteries are serviceable and the instrument can be zeroed and calibrated) in the field. If problems develop, obtain a replacement unit and perform the same functional checks.

1. Turn the instrument on and allow adequate warmup time.

2. Check the battery charge level indicator. If it is not fully charged, recharge the battery as described in the manual.

3. Turn on the pump and check for leaks by covering the sample inlet and observing the rotameter. The indicator ball should drop to zero.

4. With the pump operating, open the hnydrogen gas storage tank valve and the supply regulator to allow fuel gas to flow into the detector chamber.

5. Depress the igniter switch, observe the indicator needle for positive response, and listen for a pop. if the flame fails to light, depress the igniter switch again. Once the detector flame is lit, the unit is ready for use. Before lighting the detector flame, always be sure that the carrier gas flow (usually sample gas) is started.

6. If the instrument has internal calibration capability, perform the instrument calibration according to the procedures described in the operating manual.l

7. If the instrument has an alarm mode, set the alarm at the desired concentration.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

E. Record the calibration data on the Photoionization Detector Field Data form (Appendix 5.3). See Appendix 5.4 (Data Form Completion) for instructions.

3.2.3. Field

Before using the FID in the field, perform the following instrument checks to ensure that the equipment was not damaged during transport:

A. Follow the instrument checkout procedures described in Section 3.2.1.E.

B. If calibration to a specific hydrocarbon species is desired, complete this procedure according to the manufacturer's operating instructions.

C. Calibrate the FID daily before each use in the field.

3.3. Operation

3.3.1 Field Measurements of Organic Vapors

As with any field instrument, accurate results depend on the operator's knowledge of the operator's manual. The instructions in the manual should be followed explicitly in order to obtain accurate results.

A. Hold the sample probe in the area in question. The low sample rate allows for only very localized readings.

B. A slow sweeping motion should help prevent the bypassing of problem areas. Make sure the batteries are recharged within the time frame specified in the operator's manual. The usual length of the operating time between charges is 8 to 12 hours.

C. During drilling activities, perform FID monitoring at 5-ft intervals downhole, at the headspace, and in the breathing zone. In addition, where elevated organic vapor levels are encountered, monitoring may be performed in the breathing zone during actual drilling. When the activity does not require drilling (like surface sampling), readings may only be recorded in the breathing zone. Consult the Health and Safety Plan for the specific monitoring instructions.

D. Some units have alarms that signal the operator if the detector flame goes out. If the alarm sounds, evacuate the work area, relight the flame in a known safe area, and reenter the site.

E. Monitor fuel and combustion air supply gauges regularly to ensure sufficient gas supplies.

F. High background readings after prolonged use may indicate that the sample probe or in-line filters (in front of detector) need to be cleaned. Use pipe cleaners to clean the probe and clean air blown backwards through the probe to clean the filters. Do not use organic solvents because the detector may be saturated by the solvent.

G. Perform the routine maintenance described in the operating manual. Because the unit contains pressurized gas supplies, also perform leak-check procedures regularly. Leaking hydrogen gas is explosive.

H. Concentrations beyond the maximum full-scale capability of the instrument or in excess of 30% LEL of the sample component require system modification. Similar modification may be necessary for sampling in oxygen-deficient atmospheres. This usually entails increasing the combustion air to the detector by sample dilution or by an independent air supply. A dilution system is the apparatus required to supply a filtered, controlled air supply for analyzers that use the sample gas stream as the source of combustion air. A dilution system can dilute a gas stream by ratios up to 100:1 through the selection of various critical orifices.

3.4. Postoperation

3.4.1. Field

A. When the activity is completed or at the end of the day, carefully clean the outside of the FID with a damp disposable towel to remove any visible dirt. Return the FID to a secure area and place on charge.

B. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

C. If necessary, make sure all survey or sampling locations are properly staked and that the location ID is readily visible on the location stake.

3.4.2. Documentation

A. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

B. Review data collection forms for completeness.

3.4.3. <u>Office</u>

A. Deliver original forms and logbooks to the document control officer (with copies to the site manager and files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

C. Charge the instrument batteries.

D. If necessary, replenish supplies of the NBS traceable calibration gas.

4. SOURCES

Foxboro Analytical (A Division of The Foxboro Company). 1985. "Instruction and Service Manual, Century Systems Portable Organic Vapor Analyzer, Model OVA-128." New Haven, Connecticut.

CFR 49. 1985. Code of Federal Regulations, Title 49, U.S. Department of Transporatation, Parts 100-177. November 1, 1985. Washington, D.C.: U.S. Government Printing Office.

EPA. 1984. "Characterization of Hazardous Waste Sites - A Methods Manual: Volume II, Available Sampling Methods, Second Edition." U.S. Environmental Protection Agency document EPA-600/4-84-076, December 1984. Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, Nevada,.

5. APPENDICES

5.1. Comparison of the FID and PID

5.2. Relative Sensitivities of the FID to Some Common Organic Compounds

5.3. Equipment and Supplies Checklist

5.4. Flame Ionization Detector Field Data Form

5.5. Data Form Completion

5.6. Shipment of OVA-128 and Hydrogen Tank

APPENDIX 5.1, Concluded

	FID	PID
Maintenance	Periodically clean and inspect particle filters, valve rings, and burner chamber. Check calibration and pumping system for leaks. Recharge battery after each use.	Clean UV lamp frequently. Check calibration regularly. Recharge battery after each use.
Useful range	0-1000 ppm	0-2000 ppm
Service life	8 hrs; 3 hrs with strip chart recorder	10 hrs; 5 hrs with strip chart recorder

APPENDIX 5.1

COMPARISON OF THE FID AND PID

	FID	PID
Response	Responds to many organic gases and vapors, especially low molecular weight hydrocarbons	Responds to many organic and some inorganic gases and vapors, especially heavy hydrocarbons.
Application	In survey mode, detects total concentrations of gases and vapors. In GC mode, identifies and measures specific compounds.	In survey mode, detects total concentrations of gases and vapors. Some identification of compounds possible if GC column and standards are used.
Limitations	Does not respond to gases and vapors with a higher ionization potential than the flame detector. No temperature control.	Does not respond to methane or aliphatic chlorinated solvents. Does not respond properly in the presence of water vapor or high humidity. Does not detect a compound if the probe (lamp) has a lower energy than the compound's ionization potential.
Calibration gas	Methane and others	Benzene (1,3-butadiene) and others
Ease of operation	Requires experience to interpret correctly, especially in GC mode.	Fairly easy to use and interpret. More difficult in the GC mode.
Detection limits	0.1 ppm (methane)	0.1 ppm (benzene), depends on lamp voltage.
Response time	2-3 sec (survey mode)	3 sec for 90% of total concentration

APPENDIX 5.2

RELATIVE SENSITIVITIES OF THE FID TO SOME COMMON ORGANIC COMPOUNDS

Compound	Relative Response
Methane	100
Ethane	90
Propane	64
n-Butane	61
n-Pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Acetone	100
Methyl ethyl ketone	80
Methl isobutyl ketone	100
Methanol	15
Ethanol	25
Isopropyl alcohol	65
Carbon tetrachloride	10
Chloroform	70
Trichloroethylene	72
Vinyl chloride	35

Source: Foxboro Analytical, 1985.

APPENDIX 5.3

EQUIPMENT AND SUPPLIES CHECKLIST

- ________ Flame ionization detector (FID)
- ________ Probe extension
- ________ Operating manual
- ________ Battery charger
- ________ Spare batteries
- ________ Jeweler's screwdriver for adjustments and calibration
- ________ Refueling hose for hydrogen cylinder
- ________ NBS traceable calibration gas

APPENDIX 5.4

FLAME IONIZATION DETECTOR FIELD DATA FORM

FLAME IONIZATION DETECTOR FIELD DATA

FACILITY CODE ______________ LOG DATE ______________

LOCATION ID ______________ LOCATION TYPE ______________

LOGGER CODE ______________ FIELD REP ______________

FLAME IONIZATION DETECTOR INSTRUMENT :

MANUFACTURER ______________ MODEL ______________

SERIAL NO ______________

DATE/TIME CALIBRATED ______________ ACCEPTANCE CODE ______________

CALIBRATION GASES :	
TYPE/CYLINDER ID NO	CONCENTRATION (PPM)
1	1
2	2

COMMENTS ______________

TIME (HH:MM)	SAMPLE ID	OBSERVED READING (ppm)					DRILLING DEPTH (FT)	COMMENTS
		DH	HS	BZ	D	OT		

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

LOCATION TYPES:
- BH – BOREHOLE
- TP – TEST PIT
- SS – SOIL SAMPLE
- SB – SAMPLE BOTTLE
- SL – SURFACE LOCATION
- WL – WELL
- OT – OTHER (EXPLAIN)

OBSERVED READING:
- DH – DOWNHOLE
- HS – HEADSPACE
- BZ – BREATHING ZONE
- D – DURING DRILLING (BZ)
- OT – OTHER

COMPLETE BOLDED DATA FOR ENTRY INTO TIMS
FO-043 (1/88)

______________ FORM COMPLETED BY/DATE

______________ TECHNICAL REVIEWER/DATE

APPENDIX 5.5

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

FLAME IONIZATION DETECTOR FIELD DATA FORM

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

3. Location ID. Four-character code assigned sequentially to each borehole, test pit, or surface location where physical, chemical, biological, radiological, and other measurements are taken.

4. Location Type. Two-character code identifying where the samples were taken. There is one location type for each location ID. Location types include those listed below.

   BH--Borehole

   TP--Test Pit

   SL--Surface Location

   WL--Well

   SB--Sample Bottle

   SS--Soil Sample

   OT--Other (explain)

5. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

6. Field Rep. The name of the field representative.

7. Manufacturer. Manufacturer's name on flame ionization detector (FID) instrument used.

8. Model. Model of FID instrument.

9. Serial No. Serial No. of FID instrument.

10. Date/Time Calibrated. The day and time when the FID instrument was calibrated. Calibration should be performed daily.

11. Acceptance Code. One- character code assigned by the site manager.

12. Calibration Gases

    a. Type/Cylinder ID No. The identification of the calibration gas and the lot number on the cylinder.

    b. Concentration (ppm). The concentration of the calibration gas in parts per million (ppm).

13. Comments. Any additional information.

14. Time (HH:MM). Time when a field measurement was taken in the 24-hr clock format of hours:minutes (for example, 08:37 for 8:37 a.m. and 19:12 for 7:12 p.m.)

Conversion Table

Conventional Time	24-Hr Time
1:00 a.m.	1:00
12:00 Noon	12:00
1:00 p.m.	13:00
2:00 p.m.	14:00
3:00 p.m.	15:00
4:00 p.m.	16:00
5:00 p.m.	17:00
6:00 p.m.	18:00
7:00 p.m.	19:00
8:00 p.m.	20:00
9:00 p.m.	21:00
10:00 p.m.	22:00
11:00 p.m.	23:00
12:00 Midnight	24:00

15. Sample ID. When samples are being taken while FID monitoring is being performed, the identification number or code assigned to a particular sample like 01 is correlated with the observed readings and appropriate drilling depth if drilling is being performed. This is useful in selecting samples for analyses and in the correlation of laboratory data with FID measurements.

16. Observed Reading (ppm). FID reading at the respective location ID in the units indicated on the meter. When the calibration gas and the gas being measured for the environment are the same, the meter reads in parts per million. Measurements can be made in the breathing zone, downhole, at the headspace, or other specified locations.

17. Drilling Depth (Ft). FID monitoring is performed every 5 ft during any type of drilling. The depth of the drilling is listed in feet and can be given as the most recent interval (like 5-10) or as the ending depth (like 10).

18. Comments. Any additional information, such as type of gas being measured, if this determination can be made (for example, by labels on drums).

APPENDIX 5.6

SHIPMENT OF OVA-128 AND HYDROGEN TANK

An organic vapor analyzer (OVA) is typically shipped with a charged cylinder and a supplementary hydrogen tank to a hazardous waste site as part of the safety monitoring requirements for site characterization. The OVA and the hydrogen tank must be shipped so as to protect their integrity and to protect against potential damage or injury that may be caused from leakage/breakage of the equipment. Regulations addressing the packaging, labeling, and shipping of an OVA and a hydrogen tank are described in 49 CFR Parts 171-178.

The packaging and labeling requirements for shipment of the OVA and the hydrogen tank are summarized in the following paragraphs.

A. Organic Vapor Analyzer

The OVA must be placed in its own case or in a box to minimize damage during handling and transportation. The following labels must be placed on the container before shipping.

1. A <u>Flammable Gas</u> label (red and white label)

2. A <u>Danger</u> label (orange and black label)

3. A label no smaller than 1 inch along each dimension with <u>Hydrogen</u> clearly written on it

4. A label stating <u>Inside Packages Comply with Prescribed Specifications</u>

Personnel engaged in shipping OVAs must note that a U.S. DOT exemption is applicable to the shipment of the OVA and must be attached to the shipping papers. In addition, personnel should note that it is preferable to transport all hazardous materials on cargo aircraft (for example, Emory or Federal Express).

B. Hydrogen Tank

The hydrogen tank must be secured with a safety cap. Because the tank needs to be shipped in a vertical position (safety cap on the up end), personnel may package the tank in a box for stability and further security. It should be noted that the hydrogen tank may be shipped without a box as long as the tank can remain in an upright position. If the hydrogen tank is packaged in a box, the shipper must ensure that the box has been securely taped. The following labels must be placed on the tank or container before shipping. Personnel involved in shipping hydrogen tanks must note that hydrogen tanks cannot be shipped by passenger aircraft or rail.

1. A <u>Flammable Gas</u> label (red and white label)

2. A <u>Danger</u> label (orange and black label)

3. A label no smaller than 1 inch with UN1049 clearly written on it

4. A label no smaller than 1 inch with Hydrogen clearly written on it

5. Labels with This End Up on the container or tank point pointing toward the safety cap

6. A Cargo Aircraft Only label

7. A label stating Inside Packages Comply with Prescribed Specifications

STANDARD OPERATING PROCEDURE 6.4

TOTAL ALPHA SURFACE CONTAMINATION MEASUREMENTS

1. PURPOSE

To provide guidance for determining levels of total surface alpha contamination on equipment, vehicles, and personnel that have been in contact with material that was potentially contaminated with alpha-emitting radionuclides.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information on the scope of a given operation, related health and safety requirements, and the applicability of this procedure to the activities.

Equipment and vehicles must be monitored for contamination before release from radiologically controlled areas for unrestricted use. Levels of alpha contamination on equipment will be determined and compared to release criteria in draft DOE Order 5480.11 that are taken from the U.S. Nuclear Regulatory Commission Regulatory Guide 1.86. The limit for alpha activity applies to natural uranium, U-235, U-238, and associated decay products and is 5000 disintegrations per minute (dpm)/100 cm^2 averaged over 1 m^2 or 15,000 dpm/100 cm^2, not to exceed an area of 100 cm^2. Limits for other radionuclides apply to alpha, beta, and gamma radiations, and some are set below the detection limits for portable instruments. As a result, the applicable release criterion for alpha contamination is the minimum detectable activity above background as measured by a direct-reading alpha scintillation detector with a minimum efficiency of 20%. This measurement typically equals about 350 dpm/100 cm^2. Equipment must be decontaminated to levels that are as low as reasonably achievable and below the applicable release criterion in all cases. Personnel must be monitored for contamination before leaving a controlled area and decontaminated to the lowest reasonably achievable levels.

High-voltage plateau curves and National Bureau of Standards (NBS) traceable source calibrations must be performed on the detector semiannually to ensure proper operation. Alpha detector counting efficiencies must be determined daily before using the instrument for contamination monitoring. The counting efficiency also must be determined following any adjustments or repairs on the instrument. The counting efficiency is used to convert instrument readings to a measure of activity in units of dpm per 100 cm^2.

3. PROCEDURE

3.1. Associated Procedures

Information that applies to most field activities is provided in SOPs 1.1-1.10. In addition to the RIP, those SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
1.7	Sampling for Removable Alpha Contamination
6.11	Beta-Gamma Radiation Measurements Using a Geiger-Mueller Detector

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all field equipment. Ensure that the alpha scintillator and the ratemeter/scaler have current calibrations.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Complete the Daily Alpha Efficiency Check form (Appendix 5.2) by following instructions in Appendix 5.4, Data Form Completion.

B. Perform a daily 10-min background count and a 1-min alpha source count during use and record the results on the Daily Alpha Efficiency Check form. To perform a background count, place the probe on a clean, uncontaminated surface and record the number of counts accumulated over a period of 10 min. To perform a check source count, place the alpha source in the detector tray or against the detector surface and record the number of counts accumulated per minute (cpm).

C. Calculate the counting efficiency (E) using the formula shown below.

$$E = \frac{\text{(source cpm)} - \text{(background cpm)}}{\text{(source dpm)}}$$

D. While counting samples or performing surveys, the alpha probe may be contaminated, causing the background count rate to increase. If this is suspected, repeat the 10-min background count. If the background count rate is more than 50% above the average value, the detector should be cleaned.

3.3 Operation

3.3.1 Total Alpha Survey

A. Complete the Total Alpha Contamination Survey Data form by following instructions in Appendix 5.4, Data Form Completion.

B. List the items to be surveyed in the first column on the form. Items must be identified as specifically as possible with serial numbers, model numbers, license numbers, or other forms of unique descriptions. If the items to be surveyed need to be labeled with the assigned identification number, use an indelible marker, spray paint, or some type of permanent marker. Use a separate line of the form to list each area surveyed on the items.

C. List the surveyor's name, date of survey, and identification number of the monitoring instrument/detector.

D. Switch the instrument on, check the batteries for adequate power, and check the instrument for damage. Record the instrument daily background, efficiency, and calibration factor in the appropriate spaces. The instrument background and efficiency should be determined at least once during each operational day.

E. Monitor potentially contaminated surfaces by passing the probe face along each surface at a rate of 5 cm/sec or less. Without touching it, hold the probe face as close as possible to the surface being monitored and not more than 0.5 cm away. Be careful not to damage the Mylar face of the probe. Hold the probe steady at any area that appears to indicate an elevated reading. Record the highest reading for each separate area of the item monitored, listing a description of each area in the space provided under the first column.

F. When monitoring potentially contaminated skin and clothing surfaces, hold the probe face as close as possible to the surface being monitored, no more than
0.5 cm away. Move the probe along the surface at a rate of 5 cm/sec or less. At a minimum, monitor the areas listed below.

1. Both sides of each hand

2. Tops, sides, and bottoms of shoes or boots

3. The torso of the body, both front and back

4. All loose equipment (for example, papers, clipboards, and hand-carried tools)

G. Instrument readings will fluctuate during monitoring. Investigate any significant elevation of the meter reading by holding the meter in the suspected area. A noticeable elevation in the meter reading identifies contamination that may need to be removed.

H. Multiply each instrument reading (cpm) by the calibration factor to obtain the contamination level in dpm/100 cm^2.

I. If natural uranium, U-235, U-238, and associated decay products are the only contaminants present and the results of the survey for total alpha contamination are below the applicable release criterion for removable contamination (1000 dpm/100 cm^2), the item may be released without a survey for removable alpha contamination. If the total alpha activity is above the release criterion for removable contamination, perform the swipe or smear survey procedure. See SOP 1.7, Sampling for Removable Alpha Contamination.

J. Wash contaminated skin and equipment with water and soap. Contaminated clothing may be removed and laundered at an appropriate facility.

K. Give the survey results to the personnel responsible for releasing equipment. Equipment that fails to meet the release limits must undergo additional decontamination according to SOP 1.6, General Equipment Decontamination, and must be resurveyed.

3.4. Postoperation

3.4.1. Field

A. Turn the power off.

B. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

3.4.2. Documentation

A. Record any uncompleted work (like additional monitoring) in the logbook.

B. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

C. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the document control officer (with copies to the site manager and files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCE

NRC. 1974. Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors." U. S. Regulatory Commission, Washington, D.C.: U.S. Government Printing Office.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Daily Alpha Efficiency Check Form

5.3. Total Alpha Contamination Survey Data Form

5.4. Data Form Completion

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

________ Alpha scintillation probe (Ludlum 43-5 or the equivalent)

________ Ratemeter/scaler (Ludlum Model 3 or the equivalent)

________ Alpha check source (Am-241 or the equivalent)

________ Data forms

________ Voltage meter

________ Hand-held calculator

________ Tape measure

APPENDIX 5.2

DAILY ALPHA EFFICIENCY CHECK FORM

DAILY ALPHA EFFICIENCY CHECK

FACILITY CODE ______________________ FIELD REP ______________________

LOGGER CODE ______________________ ACCEPTANCE CODE ______________________

RATEMETER/SCALER:

MODEL NO ____________ SERIAL NO ____________ CALIBRATION DATE ____________

WINDOW OUT THRESHOLD ____________ HIGH VOLTAGE ____________ BATTERY ____________

ALPHA SCINTILLATION PROBE:

MODEL NO ____________ SERIAL NO ____________ CALIBRATION DATE ____________

SOURCE:

SERIAL NO ____________ ISOTOPE ____________ ACTIVITY ____________ DPM

LOG DATE	TIME (HH:MM)	COUNTING TIME (MIN)	BACKGROUND CPM	GROSS COUNTS	GROSS CPM	NET CPM	EFFICIENCY (NET CPM/DPM)

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

COMPLETE BOLDED DATA FOR EVERY [illegible] TIME
[illegible]

______________________ FORM COMPLETED BY/DATE

______________________ TECHNICAL REVIEWER/DATE

APPENDIX 5.3

TOTAL ALPHA CONTAMINATION SURVEY DATA FORM

TOTAL ALPHA CONTAMINATION SURVEY DATA

FACILITY CODE ____________ **LOG DATE** ____________

LOGGER CODE ____________ FIELD REP ____________

RATEMETER/SCALER: **ACCEPTANCE CODE** ____________

MODEL NO ________ SERIAL NO ________ CALIBRATION DATE ________

WINDOW OUT THRESHOLD ________ HIGH VOLTAGE ________ BATTERY ________

ALPHA PROBE:

MODEL NO ________ SERIAL NO ________ EFFICIENCY ________ CPM/DPM

PROBE FACE AREA [1] ________ CALIBRATION FACTOR [2] ________ (DPM/100cm²)/CPM

ITEM SURVEYED (SPECIFY)	GROSS COUNTS	COUNT TIME	NET CPM	CONTAMINATION[3] LEVEL (IN DPM/100cm²)	MEETS RELEASE LIMIT (YES/NO)	SWIPE NECESSARY (YES/NO)

[1] LUDLUM MODEL 43-1 PROBE FACE AREA = 78.5cm² LUDLUM MODEL 43-5 PROBE FACE AREA = 83 cm²

[2] CALIBRATION FACTOR = (100/PROBEFACE AREA (cm²))/EFFECIENCY(CPM/DPM)

[3] CONTAMINATION LEVEL = (NET CPM)(CALIBRATION FACTOR)

ACCEPTANCE CODES: A-ACCEPTABLE R-RECONNAISSANCE U-UNACCEPTABLE N-NOT DETERMINED

COMPLETE BOLDED DATA FOR ENTRY INTO TIMS

TAO- 120 (3/88)

________________ FORM COMPLETED BY/DATE

________________ TECHNICAL REVIEWER/DATE

APPENDIX 5.4

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

DAILY ALPHA EFFICIENCY CHECK

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Field Rep. The name of the field representative.

3. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

4. Acceptance Code. One-character code assigned by the site manager.

5. Ratemeter/Scaler Model No. The model number of the ratemeter/scaler.

6. Ratemeter/Scaler Serial No. The serial number of the ratemeter/scaler.

7. Ratemeter/Scaler Calibration Date. The date when the ratemeter/scaler was last calibrated.

8. Window. The window is in the out position unless otherwise specified.

9. Threshold. The adjustment for the lower energy level of the discriminator shown on the calibration sticker.

10. High Voltage. The voltage that is applied to the alpha scintillation probe shown on the calibration sticker. This voltage is determined semiannually using a voltage plateau.

11. Battery. The battery voltage reading at the beginning of the measurement.

12. Alpha Scintillation Probe Model No. The model number of the alpha detector probe.

13. Alpha Scintillation Probe Serial No. The serial number of the alpha probe.

14. Alpha Scintillation Probe Calibration Date. The date the probe was last calibrated.

15. Source Serial No. The serial number of the radiation source.

16. Source Isotope. The identity of the radioactive isotope contained in the source given as element and mass number, like Am-241.

17. Source Activity. The activity of the radioactive source in disintegrations per minute (dpm). If the check source activity is given in microcuries (1Ci), it can be converted to dpm using 1 1Ci = 2.22×10^6 dpm.

18. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

19. Time (HH:MM). The time the efficiency was determined using the 24-hr clock in the format hours:minutes.

20. Counting Time (Min). The time in minutes over which the scaler counts. Enter N/A if using a ratemeter.

21. Background cpm. The count rate with no source present.

22. Gross Counts. The number of pulses recorded by the scaler during the counting time. Enter N/A if using a ratemeter.

23. Gross cpm. The count rate with the source present given in pulses per minute.

24. Net cpm. Net counts per minute (cpm) equals gross cpm minus background cpm.

25. Efficiency (Net cpm/dpm). The ratio of the observed count rate to the true disintegration rate.

$$\text{Efficiency} = \frac{\text{Net cpm}}{\text{Source dpm}}$$

APPENDIX 5.4, Continued

TOTAL ALPHA CONTAMINATION SURVEY DATA FORM

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

3. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

4. Field Rep. The name of the field representative.

5. Acceptance Code. One-character code assigned by the site manager.

6. Ratemeter/Scaler Model No. The model number of the ratemeter/scaler.

7. Ratemeter/Scaler Serial No. The serial number of the ratemeter/scaler.

8. Ratemeter/Scaler Calibration Date. The date when the ratemeter/scaler was last calibrated.

9. Window. The window will be in the out position unless otherwise specified.

10. Threshold. The adjustment for the lower energy level of the discriminator shown on the calibration sticker.

11. High Voltage. The voltage applied to the alpha detector shown on the calibration sticker.

12. Battery. The battery voltage reading at the beginning of the measurement.

13. Alpha Probe Model No. The model number of the alpha detector probe.

14. Alpha Probe Serial No. The serial number of the alpha detector probe.

15. Alpha Probe Efficiency. The ratio of observed net count rate to the known disintegration rate of the check source from the Daily Alpha Efficiency Check form (Appendix 5.2).

16. Probe Face Area. The surface area of the Mylar window on the alpha scintillation detector in square cm. Values for Ludlum Models 43-1 and 43-5 are listed at the bottom of the form.

17. Calibration Factor. Factor that takes the detector efficiency and surface area into account to convert from cpm to dpm per 100 cm^2. The calibration factor in $(dpm/100cm^2)/cpm$ equals $(100/\text{Probe Face Area in } cm^2)/\text{efficiency in } cpm/dpm$.

18. Item Surveyed (Specify). A description or identification number of the article surveyed. A separate line on the form is used to list and describe each area to be surveyed on the article.

19. Gross Counts. The total counts collected during the counting period.

20. Count Time. The time (in minutes) during which the counts were collected.

21. Net cpm. Gross count cpm minus background cpm.

22. Contamination Level (in $dpm/100cm^2$). This is calculated by multiplying the net cpm by the calibration factor.

$$\text{Contamination level} = (\text{Net cpm})\ (\text{Calibration Factor})$$

23. Meets Release Limit (Yes/No). If the contamination level is greater than the applicable release limit, a no is written here. If the contamination level is less than the release limit, a yes is written here.

24. Swipe Necessary (Yes/No). If the total alpha contamination level exceeds the applicable removable contamination criteria, a swipe must be performed to determined the activity contribution of fixed and loose contamination.

STANDARD OPERATING PROCEDURE 6.5

SCREENING SOIL SAMPLES FOR ALPHA EMITTERS

1. PURPOSE

To provide a method of screening for alpha-emitting radionuclides in soil samples.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information about the scope of specific operations and the applicability of this procedure to the activities.

Soil samples that are collected in areas where alpha-emitting radionuclides may exist must be monitored before releasing them for laboratory analysis. No regulatory *de minimis* level has been established to designate material that contains a negligible concentration of radioactive material. This procedure compares the measurement result to background and establishes the average background value plus 3 standard deviations of the background as the criterion above which samples are considered contaminated.

The instrument used is a portable ZnS alpha detector having an efficiency of at least 15%. The minimum detectable gross-alpha activity for this method is about 50 picoCuries per gram (pCi/g).

3. PROCEDURE

3.1. Associated Procedures

Information that applies to most field activities is provided in SOPs 1.1-1.10. In addition to the RIP, those SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Obtain appropriate permission for property access.

D. Assemble the equipment and supplies listed in Appendix 5.1. Check the calibration of the alpha scintillation probe and scaler.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record the results of the calibration in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

3.2.3. Field

A. Turn the instrument power switch to on and check the batteries for adequate power.

B. Perform a source check of the instrument using the procedures outlined below.

1. Count the check source for 1 min to obtain the gross counts per minute (cpm).

2. Perform a 10-min background count. Divide the resulting counts by 10 to obtain background cpm. This count rate should be low, about 1.0 cpm for the Ludlum 43-1 probe. Any significant increase in this count rate may mean that the instrument or work area needs to be decontaminated.

3. Determine the efficiency as described in Appendix 5.4, Data Form Completion. The efficiency for the Ludlum 43-1 probe should be approximately 17%. A significant decrease or increase in the efficiency can suggest a malfunction and should be investigated.

$$\text{Efficiency} = \frac{\text{counts per minute (cpm)}}{\text{disintegrations per minute (dpm)}}$$

3.3. Operation

3.3.1 Background Samples

To provide a statistical basis for evaluating sample alpha-count data as a function of background alpha-count data, 5 background soil samples will be taken, prepared, and counted. The average and standard deviation of the background alpha count are then determined. Samples subsequently counted with a 10-min count greater than the average background plus 3 standard deviations of the background will be considered contaminated.

A. Collect a small aliquot of soil at 5 locations that have been determined to be in background areas of the installation. Using the small trowel, place the soil in double plastic sandwich bags. Seal the bags and thoroughly mix the material so that all large clods are broken.

B. When the sample appears to be uniformly mixed, transfer it into the bottom of a clean petri dish and place it under the heat lamp to dry. Make sure there is enough sample so that it will mound over the flange of the petri dish when it is dry.

C. When the sample is dry, use the lid of the petri dish to press down on the top of the sample and smooth out the surface until it is flush with the top of the container. Discard the petri dish lid into a depository for contaminated waste.

D. Count the sample for 10 min.

E. Record the accumulated counts on the Gross Alpha Screening Field Log--Background Evaluation form (Appendix 5.2) as directed in Appendix 5.4, Data Form Completion.

F. Calculate the background mean and standard deviation as described in Appendix 5.4.

3.3.2. <u>Alpha Counting of Soil Samples</u>

A. Turn on the instrument and perform a source check as described in Section 3.2.3. A source check should be performed daily.

B. Collect a small amount of soil from the locations described in the RIP. Each sample should be collected, processed, and otherwise handled according to the methods described in Section 3.3.1, steps A-C.

C. Count the sample for 10 min. Record the accumulated counts on the Gross Alpha Screening Field Log form (Appendix 5.3) as described in Appendix 5.4.

D. Compare the sample counts with the average background count plus 3 standard deviations of the background count. If the former count data are greater than the latter, the sample is considered contaminated (Y). If the counts are less, the sample is not considered contaminated (N).

3.4. Postoperation

3.4.1. <u>Field</u>

A. Ensure that the lab or work area is free of residual soil/waste material by monitoring with the alpha detector. Wipe work areas clean and dispose of waste in a designated radioactive waste container.

B. Turn the power switch on the ratemeter/scaler to the off position.

C. Place the protective cover on the alpha scintillator probe.

D. Turn the power switch on the heat lamp to the off position.

E. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

F. If necessary, make sure all survey or sampling locations are properly staked and the location ID number is readily visible on the location stake.

3.4.2. Documentation

A. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

B. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the document control officer (with copies to the site manager and files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCES

Ludlum. 1986. Model 43-1 "Instruction Manual, Alpha Scintillator." Ludlum Measurements, Inc., January 1986. Sweetwater, Texas.

Ludlum. 1982. "Instruction Manual, Model 2220 Portable Scaler." Ludlum Measurements, Inc., April 1982. Sweetwater, Texas.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Gross Alpha Screening Field Log--Background Evaluation Form

5.3. Gross Alpha Screening Field Log Form

5.4. Data Form Completion

APPENDIX 5.1

EQUIPMENT CHECKLIST

________ Ludlum model 43-1 alpha scintillation probe or equivalent

________ Ludlum model 2220 portable scaler or equivalent

________ Plastic petri dishes (1.5 cm high, 10 cm in diameter, volume of 117 cm^3)

________ Mylar film having thickness of 100 lg/cm^2

________ Thick, plastic sandwich bags

________ Heat lamp

________ Small trowel

________ Paper towels

________ Alpha check source

________ Hand-held calculator

APPENDIX 5.2

GROSS ALPHA SCREENING FIELD LOG--BACKGROUND EVALUATION FORM

GROSS ALPHA SCREENING FIELD LOG – BACKGROUND EVALUATION

FACILITY CODE ____________________ LOG DATE ____________________

LOGGER CODE ____________________ FIELD REP ____________________

RATEMETER/SCALER: ACCEPTANCE CODE ____________

MODEL NO __________ SERIAL NO __________ CALIBRATION DATE __________

WINDOW OUT THRESHOLD __________ HIGH VOLTAGE __________ BATTERY __________

PROBE:

MODEL NO __________ SERIAL NO __________ CALIBRATION DATE __________

CHECK SOURCE:

ISOTOPE __________ ACTIVITY __________ DPM SERIAL NO __________

METER READING __________ COUNTS/ __________ MIN = __________ CPM

EFFICIENCY __________ CPM/ __________ DPM = __________ CPM/DPM

COMMENTS ____

LOCATION ID OR DESCRIPTION	COORDINATES (FT)		SAMPLE ID	SAMPLE COUNTS (Counts Per 10 Minutes)
	NORTH	EAST		

MEAN = $\bar{X}$ = __________

STANDARD DEVIATION = $SD\bar{X} = \left(\frac{\bar{X}}{N}\right)^{1/2}$ = __________

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

COMPLETE BOLDED DATA FOR ENTRY INTO TIMS
CAS-100 (2/88)

____________________ FORM COMPLETED BY/DATE

____________________ TECHNICAL REVIEWER/DATE

APPENDIX 5.3

GROSS ALPHA SCREENING FIELD LOG FORM

GROSS ALPHA SCREENING FIELD LOG

PAGE ____ OF ____

FACILITY CODE ______________________ LOGGER CODE ______________________

LOG DATE ______________________ FIELD REP ______________________

LOCATION ID	COORDINATES (FT) NORTH	EAST	SAMPLE ID	SAMPLE COUNT	ABOVE CRITERIA? YES(Y) OR NO(N)

[illegible]

GROSS ALPHA SCREENING FIELD LOG

PAGE ____ OF ____

FACILITY CODE ______________________ LOGGER CODE ______________________

LOG DATE ______________________ FIELD REP ______________________

LOCATION ID	COORDINATES (FT)		SAMPLE ID	SAMPLE COUNT	ABOVE CRITERIA? YES(Y) OR NO(N)
	NORTH	EAST			

APPENDIX 5.4

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

GROSS ALPHA SCREENING FIELD LOG--BACKGROUND EVALUATION FORM

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

3. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

4. Field Rep. The name of the field representative.

5. Acceptance Code. One-character code assigned by the site manager.

6. Ratemeter/Scaler Model No. The model number of the ratemeter/scaler.

7. Ratemeter/Scaler Serial No. The serial number of the ratemeter/scaler.

8. Ratemeter/Scaler Calibration Date. The date when the ratemeter/scaler was last calibrated.

9. Window. The window will be in the out position unless otherwise specified.

10. Threshold. The adjustment for the lower energy level of the discriminator given on the calibration sticker.

11. High Voltage. The voltage that is applied to the detector given on the calibration sticker.

12. Battery. The battery voltage reading at the beginning of the measurement.

13. Probe Model No. The model number of the alpha scintillation probe.

14. Probe Serial No. The serial number of the alpha scintillation probe.

15. Probe Calibration Date. The date when the alpha scintillation probe was last calibrated.

16. Check Source Isotope. The radioactive isotope contained in the check source given as element and mass number, like Th-230.

17. Check Source Activity. The activity of the radioactive check source in disintegrations per minute (dpm). An activity given in microcuries (1Ci) can be converted to dpm using 2.22×10^6 dpm = 1 (1Ci).

18. Check Source Serial No. The serial number of the radiation check source.

19. Check Source Meter Reading. The results of a count on the check source. Check Source data consists of three fields: total counts, count time in minutes, and count rate in counts per minute (cpm).

20. Check Efficiency. The ratio of the observed count rate (cpm) to the true disintegration rate (dpm) of the check source.

    Efficiency = cpm/dpm

21. Comments. Any additional information.

22. Location ID (or Description). Four-character code assigned sequentially to each borehole, test pit, or surface location where physical, chemical, biological, radiological, and other measurements are taken.

23. Coordinates (Ft). The location where the sample was collected relative to the survey grid in feet. There are two fields in the coordinate description, north and east.

24. Sample ID. The identifying code or number given to the sample.

25. Sample Counts (Counts Per 10 Min). The count obtained on the soil sample in counts per 10 min.

26. Mean (M). The average count obtained for the background samples. The mean is calculated as shown below.

$$X = \frac{x_1 + x_2 + x_3 + x_4 + x_5}{N}$$

where,

X = mean

N = number of background measurements

$x_1 + x_2 + x_3 + x_4 + x_5$ = summation of all background counts

27. Standard Deviation (SDX). The standard deviation of the mean is calculated as shown below.

$$SDX = (X/N)^{1/2} = (X/5)^{1/2}$$

where,

N = the number of samples = 5

X = the mean

GROSS-ALPHA SCREENING FIELD LOG FORM

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Logger Code. Three-character or four-character code assigned by the site manager.

3. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

4. Field Rep. The name of the field representative.

5. Acceptance Code. One-character code assigned by the site manager.

6. Ratemeter/Scaler Model No. The model number of the ratemeter/scaler.

7. Ratemeter/Scaler Serial No. The serial number of the ratemeter/scaler.

8. Ratemeter/Scaler Calibration Date. The date when the ratemeter/scaler was last calibrated.

9. Window. The window will be in the out position unless otherwise specified.

10. Threshold. The adjustment for the lower energy level of the discriminator given on the calibration sticker.

11. High Voltage. The voltage that is applied to the detector given on the calibration sticker.

12. Battery. The battery voltage reading at the beginning of the measurement.

13. Probe Model No. The model number of the alpha scintillation probe.

14. Probe Serial No. The serial number of the alpha scintillation probe.

APPENDIX 5.4, Concluded

15. Probe Calibration Date. The date when the alpha scintillation probe was calibrated.

16. Check Source Isotope. The radioactive isotope contained in the check source given as element and mass number, like Th-230.

17. Check Source Activity. The activity of the radioactive check source in disintegrations per minute (dpm). An activity given in microcuries (1Ci) can be converted to dpm using 2.22×10^6 dpm = 1 1Ci.

18. Check Source Serial No. The serial number of the radiation check source.

19. Source Check Meter Reading. The results of a count on the check source. Check source data consists of three fields: total counts, count time in minutes, and count rate in counts per minute (cpm).

20. Source Check Efficiency. The ratio of the observed count rate (cpm) to the true disintegration rate (dpm) of the check source.

    Efficiency = cpm/dpm

21. Average Background Count plus 3 Standard Deviations. This quantity has been derived from counts on background samples. See entries 26 and 27 of this appendix (Gross Alpha Screening Field Log--Background Evaluation form) for these calculations.

22. Comments. Any additional information.

23. Location ID. Four-character code assigned sequentially to each borehole, test pit, or surface location where physical, chemical, biological, radiological, and other measurements are taken.

24. Coordinates (Ft). The location where the sample was collected relative to the survey grid in feet. There are two fields in the coordinate description, north and east.

25. Sample ID. The identifying code or number given to the sample.

26. Sample Count. The count obtained on the soil sample in counts per minute.

27. Above Criteria? A flag column to mark samples for further consideration. A yes (Y) is entered if the sample count exceeds the criteria; a no (N) is entered if the sample count does not exceed the criteria.

STANDARD OPERATING PROCEDURE 6.7

NEAR SURFACE AND SOIL SAMPLE SCREENING FOR LOW-ENERGY GAMMA RADIATION USING THE FIDLER

1. PURPOSE

To describe the procedure in which a field instrument for the detection of low-energy radiation (FIDLER) is used to monitor surfaces and soil samples for the presence of low-energy gamma radiations that accompany some alpha emissions.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information on the scope of specific operations, related health and safety requirements, and the applicability of this procedure.

The FIDLER uses a thin, 5-inch-diameter sodium iodide (NaI) crystal to detect low-energy radiation. The NaI crystal is optically coupled to a quartz light pipe and installed in a standard 5-inch probe housing that has an entrance window of beryllium. The principal use of this detector is for photons with energies less than 75 kilo-electron volts (keV).

The FIDLER probe can be used to scan individual samples for low-energy photons that normally accompany alpha emissions. Uranium is principally an alpha emitter. However, the radiation from its daughter products includes low-energy photons, principally L-orbital x rays from thorium. In the case of U-238, for example, two low-energy photons from Th-234 can be detected by the FIDLER. During most investigations, the instrument will be adjusted for maximum response for the 63 keV photon from Th-234 or the 60 keV photon of Am-241 formed by the beta decay of Pu-241.

Data from these measurements are presented as gross counts in the 60 keV energy range. The combination of this information with gross alpha counts of the same sample conducted according to SOP 6.5, Screening Soil Samples for Alpha Emitters, can be used to determine the presence or absence of radionuclides.

Included in this procedure are instructions for 1) initial instrument setup (voltage plateau), 2) daily response standardization using a sealed check source, 3) determination of the instrument's response to terrestrial background radiation, and 4) use of the instrument to scan ground surface areas and samples.

3. PROCEDURE

3.1. Associated Procedures

Information that applies to most field activities is provided in SOPs 1.1-1.10. In addition to the RIP, those SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination
6.5	Screening Soil Samples for Alpha Emitters

3.2. Preparation

3.2.1. Office

A. Review the RIP and SOPs listed in Section 3.1.

B. Coordinate schedules/actions with the installation staff.

C. Assemble the equipment and supplies listed in Appendix 5.1. Ensure the proper operation of all equipment.

D. Obtain appropriate permission for property access.

E. Before the FIDLER can be used in the field, it is necessary to determine the correct operating voltage. This is accomplished by determining the plateau for background radiation and for radiation from a source of Am-241 (60 keV) in which the intensity is several times greater than background radiation levels. Determine the operating voltage once each week.

1. Inspect the FIDLER, the ratemeter/scaler, and interconnecting cable for obvious damage.

2. If no damage is observed, adjust the high voltage to 0 volts before connecting the FIDLER and the ratemeter/scaler.

3. Connect the FIDLER to the ratemeter/scaler in an area that has exhibited background radiation in previous measurements.

4. Turn the ratemeter/scaler selector switch to the high voltage setting and slowly adjust the high voltage to 900 volts (V).

5. Place the FIDLER in a position so that a series of 0.5-min counts can be made at various high-voltage settings.

6. Make three 0.5-min readings and record the voltage, count time, counts, and counts per minute in the columns on the Plateau Curve Record. When these three readings have been completed, adjust the high voltage upward 40 to 50 V. Repeat the three readings. Continue this procedure until three recordings have been made at a high-voltage setting of 1400 V. Do not exceed 1400 V.

7. Place the Am-241 source approximately 1 inch from the beryllium entrance window near the center of the probe and repeat the series of 0.5-min readings for high-voltage settings between 900 and 1400 V.

8. On the Plateau Curve Record, plot the FIDLER response as a function of high voltage. Between 1100 and 1300 V, there is little change in the detector's response. This represents the operating plateau. Set the ratemeter/scaler high voltage at the midpoint of the plateau (typically 1200 V) for field operation. Minor fluctuations in the high voltage caused by environmental conditions or battery drain will have little effect on the count rate. Record this ratemeter/scaler voltage on the Plateau Curve Record form.

3.2.2. <u>Documentation</u>

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check and information concerning the initial setup of the FIDLER in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for a current list of information used in the completion of data forms.

E. Record information concerning the initial setup of the FIDLER on the Plateau Curve Record form (Appendix 5.2). Instructions for completing the form are in Appendix 5.5 (Data Form Completion).

3.2.3. <u>Field</u>

A. Daily Source Check

1. Establish a fixed geometry between the detector and the source so that their relative position is a matter of record and reproducible from one work period to the next.

2. Make five 1-min counts with the Am-241 source in its check position. Record each count in the logbook. Repeat this step twice daily when the instrument is in use or at any new locations.

3. Determine the average and standard deviation of the five 1-min counts. Record these values and three times the standard deviation in the logbook.

The average source count (X) = $\dfrac{x_1+x_2+x_3+x_4+x_5}{5}$

The standard deviation of the average source count (SDX) = $(X)^{1/2}$

B. Monitoring the performance of the FIDLER

1. Prepare a control chart at the beginning of the site characterization and use it each day to record the FIDLER's response to the Am-241 source.

2. On a piece of linear graph paper, place consecutive calendar dates on the x-axis. Define a range along the y-axis that includes the average FIDLER source count ± 3 standard deviations. Draw three horizontal lines that intersect the y-axis at these three points.

3. Determine the average count rate and plot this value on the control chart for that day. If the average count rate falls within the ±3 standard deviations as defined above, the FIDLER may be used for field measurements. If the average count rate is not within this range, corrective action must be taken (see Section 3.2.3.C).

C. Corrective Action

1. Check the ratemeter/scaler calibration due date.

2. Check to see that the ratemeter/scaler high voltage is set at the plateau midpoint.

3. Turn off the ratemeter/scaler and disconnect the cable to the FIDLER. Clean the cable and chassis connectors with ethyl alcohol and let dry.

4. Reconnect the cable, turn on the ratemeter/scaler, and check the voltage setting.

5. Check the source-to-detector distance and make any necessary corrections.

6. Repeat the daily source check procedure. If the FIDLER response is within the range of the average count rate ± 3 standard deviations, the unit may be used. If the average count rate is still outside the control boundary, turn off the instrument and use a substitute instrument. Repeated failures will require attention by the manufacturer. The FIDLER is temperature sensitive and will not function correctly at temperatures below 32°F.

D. Determination of Background

1. In order to provide a statistical basis to determine if samples or locations are contaminated, calculate the mean background and standard deviation.

   a. In a location designated as background (not in the contaminated area) or using five soil samples collected from a background area, perform a series of five 1-minute counts with the FIDLER probe in the same position as it will be for screening samples in locations (see Sections 3.3.1 and 3.3.2).

   b. Determine the mean and standard deviation of the five background counts.

$$\text{Mean} = X = \frac{x_1+x_2+x_3+x_4+x_5}{5}$$

where

x_1, x_2, x_3, x_4, x_5 = the background counts

standard deviation = SDX = $(X)^{1/2}$

2. The contamination criterion used for further samples is the mean background plus 3 standard deviations (X + 3SDX). Samples with 1-min counts greater than this criterion should be considered contaminated.

3. Record this number or criterion on the FIDLER Soil Sample Screening Log (Appendix 5.3) or the FIDLER Measurement Data form (Appendix 5.4), depending on the type of screening to be performed.

3.3. Operation

3.3.1 Screening Soil Samples

A. Record the soil sample screening data on the FIDLER Soil Sample Screening Log form (Appendix 5.3) following the instructions in Appendix 5.5, Data Form Completion.

B. Place the soil samples in the petri dishes (fill to the top).

C. The steps for screening samples are described below.

1. Place the soil sample container (petri dish) in the counting shield.

2. Place the FIDLER probe in a counting jig inside the lead shield so that it is positioned above the center of a sample container holder. Adjust the height so that the FIDLER is one inch above the sample container. Close the shield door.

3. Turn the ratemeter/scaler selector switch to preset time and set the time for one min. Push the reset button to start and count.

4. Record the counts and the counting time on the FIDLER Soil Sample Screening Log form.

6. Remove the sample container, store it in sample archive, and repeat with additional samples.

3.3.2. Near-Surface Screening

A. The FIDLER Measurement Data form (Appendix 5.4) is completed as described in Appendix 5.5, Data Form Completion.

B. Determine that the FIDLER system has been checked and is ready for field measurements.

C. Refer to the RIP for the areas to be scanned, the number of people required, time requirements, and special instructions.

D. Subdivide the grid block squares into square (or regular) grid blocks, the total area of which can be scanned in 0.5 or 1-min intervals. Use a calibrated measurement tape.

E. Drainage paths can only be scanned with a FIDLER if the area is free of standing or flowing water. If the area is dry, place grid stakes at regular intervals between the preexisting stakes.

F. Record scan measurements as integral counts over the area to be scanned. Pulses from the FIDLER will be summed for 0.5 min or 1 min. Turn the main selector switch of the ratemeter/scaler to either 0.5 or 1 min (as specified in the RIP).

G. Begin scans at one corner of a grid block and progress in a serpentine pattern over the entire block, ending at the diagonally opposite corner of the block. Push the ratemeter/scaler reset button as the scan begins. With practice, the timed count should end upon reaching the opposite corner. During the scan, the field representative must listen to the audible signal from the meter. Although scanning speed should not be slowed when increased audible signals are heard, note the presence of apparent hot spots when recording the integrated count for the scan.

H. After completing the scan for an individual grid block, record the integrated count in its respective position on the FIDLER Measurement Data form (Appendix 5.4). Place a check mark above the recorded count to signify that anomalous or hot spot areas may exist on the basis of audible signals for that grid block.

I. Compare the location count rate to the contamination criterion (average background and 3 standard deviations). If the count rate is greater, the location is marked Y for further study or characterization.

3.4. Postoperation

3.4.1. Field

A. Ensure that all equipment is accounted for, decontaminated (see SOP 1.6, General Equipment Decontamination), and ready for shipment.

B. If necessary, make sure all survey or sampling locations are properly staked and the location ID is readily visible on the location stake.

C. Ensure that all radiological sources and standards have been stored in a locked area.

3.4.2. Documentation

A. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

B. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the document control officer (with copies to the site manager and files) for eventual delivery to the Department of Energy.

B. Inventory Equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCE

Becron. 1985. "Technical Manual, Model: Labtech Scaler/Ratemeter/Analyzer with 2-Channel Option." Bicron Corporation, Newbury, Ohio.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Plateau Curve Record

5.3. FIDLER Soil Sample Screening Log Form

5.4. FIDLER Measurement Data Form

5.5. Data Form Completion

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

________ FIDLER probe

________ Ratemeter/scaler with voltage indicator and optional headphones

________ Connector cable

________ Lead shield and counting jig (optional)

________ Plan view (site map) of the area to be surveyed that includes grid system coordinates

________ Calibrated measurement tape or chain

________ Am-241 source or the equivalent

________ Hand-held calculator

________ FIDLER heat shield, if available

________ Linear graph paper for the performance control chart

________ Petri dishes for soil samples

APPENDIX 5.2

PLATEAU CURVE RECORD

PLATEAU CURVE RECORD PAGE 1 OF ____

FACILITY CODE ______________ LOG DATE ______________

LOGGER CODE ______________ FIELD REP ______________

RATEMETER/SCALER: ACCEPTANCE CODE ______________

MODEL NO __________ SERIAL NO __________ CALIBRATION DATE __________

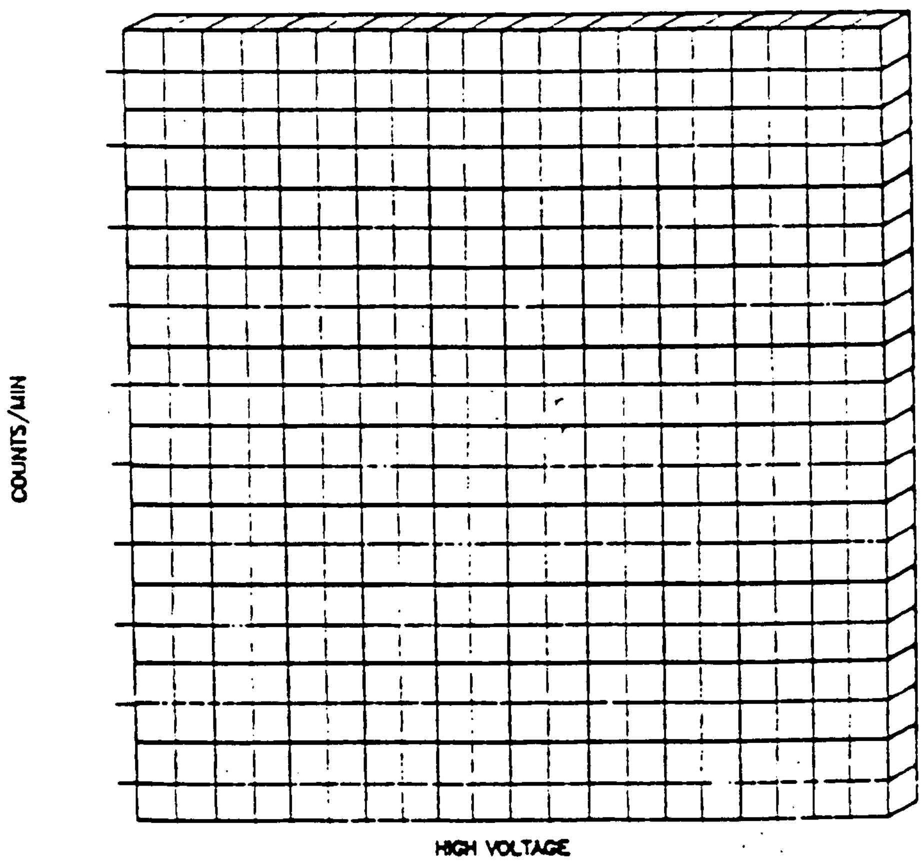
WINDOW __________ THRESHOLD __________ BATTERY __________

PROBE:

MODEL NO __________ SERIAL NO __________ HIGH VOLTAGE __________

CHECK SOURCE:

SERIAL NO __________ ISOTOPE __________ ACTIVITY __________



ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

[illegible]

[illegible]

______________ FORM COMPLETED BY/DATE

______________ TECHNICAL REVIEWER/DATE

APPENDIX 5.3

FIDLER SOIL SAMPLE SCREENING LOG

FIDLER SOIL SAMPLE SCREENING LOG

PAGE 1 OF ____

FACILITY CODE ____________ LOG DATE ____________

LOGGER CODE ____________ FIELD REP ____________

RATEMETER/SCALER: ACCEPTANCE CODE ____________

MODEL NO ____________ SERIAL NO ____________ CALIBRATION DATE ____________

WINDOW ________ THRESHOLD ________ HIGH VOLTAGE ________ BATTERY ________

NaI PROBE :

MODEL NO ____________ SERIAL NO ____________ CALIBRATION DATE ____________

CHECK SOURCE:

ISOTOPE ________ ACTIVITY ____________ DPM SERIAL NO ________

SOURCE CHECK
METER READING ________ COUNTS/________ MIN = ________ CPM
(WITHIN ± 3 STANDARD DEVIATIONS?[1] ______ (Y/N))

AVERAGE BACKGROUND + 3 STANDARD DEVIATIONS = ______ CPM

COMMENTS ____

LOCATION ID	COORDINATES (FT)		SAMPLE ID	COUNTS (=CPM)	CONTAMINATED YES/NO	ESTIMATED[2] pCi/gram
	NORTH	EAST				

1 SOURCE CHECK WITHIN ± 3 STANDARD DEVIATIONS (YES/NO), FROM THE CONTROL CHART

2 THE pCi/gram RADIONUCLIDE CONCENTRATION CAN BE ESTIMATED ONLY IF FIELD CALIBRATION FACTORS ARE AVAILABLE

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

COMPLETE BOLDED DATA FOR ENTRY [illegible]
[illegible]

FORM COMPLETED BY/DATE ____________ TECHNICAL REVIEWER/DATE ____________

APPENDIX 5.4

FIDLER MEASUREMENT DATA FORM

FIDLER MEASUREMENT DATA — PAGE 1 OF ___

FACILITY CODE ______________ LOG DATE ______________

LOGGER CODE ______________ FIELD REP ______________

RATEMETER/SCALER: ACCEPTANCE CODE ______________

MODEL NO ________ SERIAL NO ________ CALIBRATION DATE ________

WINDOW ______ THRESHOLD ________ VOLTAGE ________ BATTERY ________

NaI PROBE:

MODEL NO ________ SERIAL NO ________ CALIBRATION DATE ________

CHECK SOURCE:

ISOTOPE ________ ACTIVITY ________ DPM SERIAL NO ________

SOURCE CHECK

METER READING ________ COUNTS/________ MIN = ________ CPM

(WITHIN ± 3 STANDARD DEVIATIONS?[1] ________ (Y/N)

AVERAGE BACKGROUND + 3 STANDARD DEVIATIONS = ________

COMMENTS ______________________________

LOCATION ID	GRID BLOCK SCANNED (FROM N.E. CORNER)		INTEGRATED COUNT (CPM)	AUDIBLE (Y)es or (N)o	CONTAMINATED (Y)es or (N)o
	NORTH	EAST			

[1] SOURCE CHECK WITH ± 3 STANDARD DEVIATIONS. (YES/NO) FROM THE CONTROL CHART

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

COMPLETE BOLDED DATA FOR ENTRY INTO TIMS
[illegible]

______________ FORM COMPLETED BY/DATE

______________ TECHNICAL REVIEWER/DATE

APPENDIX 5.5

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

PLATEAU CURVE RECORD

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

3. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

4. Field Rep. The name of the field representative.

5. Acceptance Code. One-character code assigned by the site manager.

6. Ratemeter/Scaler Model No. The model number of the ratemeter/scaler.

7. Ratemeter/Scaler Serial No. The serial number of the ratemeter/scaler.

8. Ratemeter/Scaler Calibration Date. The date when the ratemeter/scaler was last calibrated.

9. Window. The window will be in the out position unless otherwise specified.

10. Threshold. The adjustment for the lower energy level of the discriminator shown on the calibration sticker.

11. Battery. The battery voltage reading at the beginning of the measurement.

12. Probe Model Number. The model number of the FIDLER probe.

13. Probe Serial Number. The serial number of the FIDLER probe.

14. Probe High Voltage. The final voltage setting that will be applied to the detector, as determined by the Plateau Curve procedure. For the FIDLER, the operating voltage should be about 1200V.

15. Check Source Serial No. The serial number of the radiation check source.

16. Check Source Isotope. The radioactive isotope contained in the check source given as element and mass number, like Am-241.

17. Check Source Activity. The activity of the radioactive check source in disintegrations per minute (dpm). An activity given in microcuries (uCi) can be converted to dpm using 2.22×10^6 dpm = 1 uCi.

18. Counts/Min. The count rate given in counts per minute (cpm).

19. High Voltage. The voltage applied to the detector during the collection of the associated counts.

APPENDIX 5.5, Continued

FIDLER SOIL SAMPLE SCREENING LOG

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

3. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

4. Field Rep. The name of the field representative.

5. Acceptance Code. One-character code assigned by the site manager.

6. Ratemeter/Scaler Model No. The model number of the ratemeter/scaler.

7. Ratemeter/Scaler Serial No. The serial number of the ratemeter/scaler.

8. Ratemeter/Scaler Calibration Date. The date when the ratemeter/scaler was last calibrated.

9. Window. The window will be in the out position unless otherwise specified.

10. Threshold. The adjustment for the lower energy level of the discriminator shown on the calibration sticker.

11. High Voltage. The voltage setting that is applied to the probe as determined by the Plateau Curve procedure.

12. Battery. The battery voltage reading at the beginning of the measurement.

13. NaI Probe Model No. The model number of the FIDLER probe.

14. NaI Probe Serial No. The serial number of the FIDLER probe.

15. NaI Probe Calibration Date. The date when the FIDLER probe was last calibrated.

16. Check Source Isotope. The radioactive isotope that the source contains, given as element and mass number, like Am-241.

17. Check Source Activity. The activity of the check source, measured in disintegrations per minute (dpm). An activity given in microcuries can be converted to dpm using 2.22×10^6 dpm = 1 uCi.

18. Check Source Serial No. The serial number of the check source.

19. Source Check Meter Reading. The results of a count on a check source. The check source data consists of three fields: total counts, counting time in minutes, and count rate in counts per minute (cpm).

20. Within ± 3 Standard Deviations (Y/N). This field describes the performance of the FIDLER, from the control chart in 3.2.3.B., Field Preparation.

21. Average Background + 3 Standard Deviations (cpm). This field gives the average background count rate + 3 standard deviations of the average count rate. It is used as a contamination criterion. Count rates greater than this are considered contaminated. Count time equals 1 min.

$$X = \text{Average or Mean Background} = \frac{x_1+x_2+x_3\ldots x_n}{N}$$

where

x_1, x_2, x_3 etc = individual background counts

N = the number of counts taken

SDX = standard deviation of the average background = $(X)^{1/2}$

22. Comments. Any additional information.

23. Location ID. Four-character code assigned sequentially to each borehole, test pit, or surface location where physical, chemical, biological, radiological, and other measurements are taken.

24. Coordinates (Ft). The location of the FIDLER measurement on the survey grid in units of feet. The two coordinate fields are in the format north and east.

25. Sample ID. The identifying code or number given to the sample.

26. Counts (=cpm). The number of counts registering on the FIDLER meter during the 1-min counting period.

27. Contaminated (Yes/No). If the counts per 1 min obtained are greater than the average background plus 3 standard deviations, the sample is considered contaminated. Enter Yes or Y if contaminated and No or N if not contaminated.

28. Estimated pCi/gram. If calibration factors are available for the specific site under investigation, the FIDLER cpm can be converted to a pCi/gram concentration. Enter N/A if these factors are not available.

APPENDIX 5.5, Continued

FIDLER MEASUREMENT DATA FORM

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date the information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

3. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

4. Field Rep. The name of the field representative.

5. Acceptance Code. One-character code assigned by the site manager.

6. Ratemeter/Scaler Model No. The model number of the ratemeter/scaler.

7. Ratemeter/Scaler Serial No. The serial number of the ratemeter/scaler.

8. Ratemeter/Scaler Calibration Date. The date when the ratemeter/scaler was last calibrated.

9. Window. The window will be in the out position unless otherwise specified.

10. Threshold. The adjustment for the lower energy level of the discriminator shown on the calibration sticker.

11. Voltage. The voltage setting that is applied to the probe, as determined by the Plateau Curve procedure.

12. Battery. The battery voltage reading at the beginning of the measurement.

13. NaI Probe Model No. The model number of the FIDLER probe.

14. NaI Probe Serial No. The serial number of the FIDLER probe.

15. NaI Probe Calibration Date. The date when the FIDLER probe was last calibrated.

16. Check Source Isotope. The radioactive isotope that the source contains, given as element and mass number, like Am-241.

17. Check Source Activity. The activity of the check source, measured in disintegrations per minute (dpm). An activity given in microcuries (uCi) can be converted to dpm using 2.22×10^6 dpm = 1 uCi.

18. Check Source Serial No. The serial number of the check source.

19. Source Check Meter Reading. The results of a count on a check source. Check source data consists of three fields: total counts, count time in minutes, and count rate in cpm.

20. Within ± 3 Standard Deviations. This field describes the performance of the FIDLER, from the control chart in Section 3.2.3.B, Field Preparation. Enter Y (yes) or N (no).

21. Average Background + 3 Standard Deviations. This field gives the average background count rate (cpm) + 3 standard deviations of the average. It is used as a contamination criterion; count rates greater than this number indicate contaminated areas.

$$X = \text{Average or Mean Background} = \frac{x_1+x_2+x_3 \ldots x_n}{N}$$

where

x_1, x_2, x_3, etc. = individual background counts

N = the number of counts taken

SDX = standard deviation of the average background = $(X)^{1/2}$

22. Comments. Any additional information.

23. Location ID. Four-character code assigned sequentially to each borehole, test pit, or surface location where physical, chemical, biological, radiological, and other measurements are taken.

24. Grid Block Scanned (From N.E. Corner). The location of the grid block that was scanned, identified by the survey coordinates of the northeast corner relative to the survey grid in units of feet. There are two fields in the coordinate description: north and east.

25. Integrated Count (cpm). The count rate in counts per minute obtained from the walkover scan of the grid.

26. Audible. If an audible anomaly was noted, enter YES; if no audible anomaly was detected, enter NO.

27. Contaminated. If the count rate recorded is greater than the average background plus 3 standard deviations, the location is considered contaminated (Y). If it is less, it is not considered contaminated (N).

STANDARD OPERATING PROCEDURE 6.16

HEAT STRESS MONITORING

1. PURPOSE

To outline the procedure for monitoring heat stress and other measures for protecting workers from heat exhaustion and heat stroke in warm environments.

2. DISCUSSION

The Remedial Investigation Plan (RIP) provides information on the scope of a given operation, related health and safety requirements, and the applicability of this procedure to the activities.

Heat stress is often the major hazard facing workers at hazardous waste sites, especially when respirators and clothing that are semipermeable (Tyvek coveralls) or impermeable are worn in warm or hot weather. Although monitoring heat stress is an important factor in preventing heat-related injuries, the proper planning, budgeting, and scheduling of site activities are equally important. In addition to monitoring heat stress, heat-stress problems can be mitigated by employing some of the measures described below.

- Have workers drink plenty of fluids.
- Provide shade.
- Schedule work in the early morning, evening hours, or at night.
- Schedule work during the cool part of the year.
- Provide workers with cooling vests.
- Provide workers with a cool-down room in the contaminated zone next to the area in which they are working.
- Set up a tent and refrigerate the work area.
- Have two or more crews work on alternate shifts. One or more crews can cool down, while the other crew works in the heat.

3. PROCEDURE

3.1. Associated Procedures

Information that applies to most field activities is provided in SOPs 1.1-1.10. In addition to the RIP, those SOPs provide guidance that may supplement the information in this procedure. They should be consulted as necessary to obtain specific information about equipment and supplies; sample collection, preservation, packaging, and shipping; decontamination procedures; and documentation requirements. Procedures directly associated with this SOP are listed below.

SOP No.	SOP Title
1.1	General Instructions for Field Personnel
1.6	General Equipment Decontamination

3.2. Preparation

3.2.1. Office

A. Review the RIP, the SOPs listed in Section 3.1, and the Health and Safety Plan.

B. Obtain and confirm the accurate operation of field equipment listed in Appendix 5.1.

3.2.2. Documentation

A. Obtain a logbook from the QA officer.

B. Record results of the equipment check in the logbook.

C. Obtain a sufficient number of the appropriate ER Program data collection forms (see INDEX TO SOPs).

D. Consult the ER Program data administrator for current information information used in the completion of data forms.

3.2.3. Field

A. Place a thermometer in a shaded location of the work area to measure the ambient air temperature.

B. As described in Appendix 5.3, Data Form Completion, record the time, temperature, and personnel baseline pulse rates and indicate whether the day is cloudy or sunny on the Heat Stress Monitoring Record form (Appendix 5.2).

C. Calculate the adjusted air temperature as shown below.

$$ta\ adj\ F^\circ = ta\ F^\circ + [13 \times (\%\ sunshine/100)]$$

where

ta F° = the temperature indicated on the thermometer in F°

3.3. Operation

3.3.1 Monitoring Heat Stress

A. Complete the Heat Stress Monitoring Record form by following instructions in Appendix 5.3.

B. Record baseline data obtained in Section 3.2.3.B. and set the timer for the period of time indicated on the National Institute of Safety and Health (NIOSH) Heat Stress Monitoring Table (Appendix 5.4).

C. When the working time has elapsed, have workers find their own pulse and count the number of times their heart beats in 15 or 30 sec. Convert pulse rates to beats per minute (bpm) and record the time and weather conditions on the Heat Stress Monitoring Record form.

D. Have the workers take a break in the shade (or cooler room) until their pulse rates drop to a value close to their baseline rates. This length of time will vary with site-specific conditions.

   1. If no crew member had a pulse rate that was above 110 bpm at the beginning of the break, continue following the suggested work durations shown in Appendix 5.4.

   2. If a crew member had a pulse rate above 110 bpm, the next work period should be two-thirds as long as the previous work period.

      EXAMPLE: It is 80°F in the shade. There is no cloud cover, and the crew is working in impermeable clothing. The effective temperature would be 93°F, and the table in Appendix 5.4 suggests a 15-min work period. If a worker had a pulse rate above 110 bpm at the beginning of a break, the next work period should be 10 min long. If hot weather conditions remain unchanged and a worker had a pulse rate above 110 bpm at the beginning of the next break, then the third work period should be shortened to 6 and 2/3 min.

E. Identify heat-sensitive workers and assign some of their duties to individuals with a lower sensitivity to heat.

F. Take appropriate action if you observe any of the early signs of heat stress listed below.

   1. Clumsiness or lack of coordination

   2. Mental confusion or poor judgment

   3. Frequent bending over or leaning against objects

   4. Going to unusual lengths to get out of sun

5. Workers who claim that they are not too hot when demonstrating one or more of these symptoms

G. Be prepared to give first aid and transport workers suffering from severe heat stress or heat stroke to medical facilities.

3.4. Postoperation

3.4.1. Field

Ensure that all equipment is accounted for and decontaminated (see SOP 5.6, General Equipment Decontamination).

3.4.2. Documentation

A. Complete logbook entries, verify the accuracy of entries, and sign/initial all pages.

B. Review data collection forms for completeness.

3.4.3. Office

A. Deliver original forms and logbooks to the document control officer (with copies to the site manager and files) for eventual delivery to the Department of Energy.

B. Inventory equipment and supplies. Repair or replace all broken or damaged equipment. Replace expendable items. Return equipment to the equipment manager and report incidents of malfunction or damage.

4. SOURCES

American Red Cross. 1979. Standard First Aid and Personal Safety. 2d ed. Garden City, New York: Doubleday and Company, Inc.

NIOSH. 1985. "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities." U.S. Department of Health and Human Services, Center for Disease Control, National Institute for Occupational Safety and Health, Atlanta, Georgia.

5. APPENDICES

5.1. Equipment and Supplies Checklist

5.2. Heat Stress Monitoring Record Form

5.3. Data Form Completion

5.4. NIOSH Heat Stress Monitoring Table

APPENDIX 5.1

EQUIPMENT AND SUPPLIES CHECKLIST

________ 60-min timer

________ Stopwatch

________ Thermometer

APPENDIX 5.2

HEAT STRESS MONITORING RECORD

HEAT STRESS MONITORING RECORD

FACILITY CODE ______________________ LOG DATE ______________________

LOGGER CODE ______________________ FIELD REP ______________________

ACCEPTANCE CODE ______________________

WORKER NO 1 NAME AND SS NO ______________________

WORKER NO 2 NAME AND SS NO ______________________

WORKER NO 3 NAME AND SS NO ______________________

WORKER NO 4 NAME AND SS NO ______________________

WORKER NO 5 NAME AND SS NO ______________________

TIME (HH:MM)	AIR TEMP	% SUNSHINE	ADJ TEMP (°F)	ACTIVITY CODE	PULSE RATE OF WORKER (BEATS PER MINUTE)				
					WORKER 1	WORKER 2	WORKER 3	WORKER 4	WORKER 5

ACCEPTANCE CODES: A—ACCEPTABLE R—RECONNAISSANCE U—UNACCEPTABLE N—NOT DETERMINED

ACTIVITY CODES: BL - BASELINE W - WELL SAMPLING D - DRILLING O - OTHER (SPECIFY)
M - SURFACE MEASUREMENTS BR - BREAK T - TEST PITTING S - SURFACE SAMPLING Z - OBSERVING

COMPLETE BOLDED DATA FOR ENTRY INTO TIMS

HBA-108 (1/88)

______________________ FORM COMPLETED BY/DATE

______________________ TECHNICAL REVIEWER/DATE

APPENDIX 5.3

DATA FORM COMPLETION

Use a pen with black ink that is not water soluble (not a felt-tip pen). Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. If any procedure was not performed as prescribed, give the reason for the change or omission on the form. To change an entry, draw a single line through it, add the correct information above it, and initial the change.

HEAT STRESS MONITORING RECORD

1. Facility Code. Five-character code abbreviating the facility name where program activity is being conducted. The first three characters indicate the facility, and the remaining two numbers designate the specific site within the facility.

2. Log Date. The date that information recorded on the form was obtained in the format DD-MMM-YY (01-JAN-88).

3. Logger Code. Three-character or four-character code identifying the company responsible for collecting the information recorded on the form.

4. Field Representative. The name of the field representative.

5. Acceptance Code. One-character code assigned by the site manager.

6. Worker Name and SS No. Name(s) and social security number(s) of the worker(s).

7. Time (HH:MM). The 24-hr clock (see conversion table below) will be used.

Conversion Table

Conventional Time	24-Hr Time
1:00 a.m.	1:00
12:00 noon	12:00
1:00 p.m.	13:00
2:00 p.m.	14:00
3:00 p.m.	15:00
4:00 p.m.	16:00
5:00 p.m.	17:00
6:00 p.m.	18:00
7:00 p.m.	19:00
8:00 p.m.	20:00
9:00 p.m.	21:00
10:00 p.m.	22:00
11:00 p.m.	23:00

12:00 midnight 24:00

APPENDIX 5.3, Concluded

8. Air Temperature. The air temperature (°F) measured in the shade.

9. % Sunshine. If cloudy, enter a 0; if sunny, enter 100. If partly cloudy, enter 50.

10. Adj. Temp (°F). The adjusted temperature in °F determined by the formula below.

$$ta\ adj\ F^\circ = ta\ F^\circ\ [13 \times (\%\ sunshine/100)]$$

11. Activity Code. Code describing ongoing activity.

Activity Code Table

Activity	Code
Baseline	BL
Break	BR
Drilling	DR
Grouting	GR
Logging	LO
Measurements	ME
Sampling	SA
End of Break	EB

12. Pulse Rate of Worker (Beats per minute). Pulse rate is measured in beats per minute.

APPENDIX 5.4

NIOSH HEAT STRESS MONITORING TABLE[a]

ADJUSTED TEMPERATURE[b]	NORMAL WORK EMSEMBLE[c]	IMPERMEABLE ENSEMBLE
90°F(32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°-90°F(30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F(28.1°-30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.°F(25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

Source: Reference [13]

[a]For work levels of 250 kilocalories/hour.

[b]Calculate the adjusted air temperature (ta adj) by using this equation: ta adj F° = ta. F° + [13 x (% sunshine/100)]. Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percentage of sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow 0 percent sunshine = no shadows).

[c]A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.